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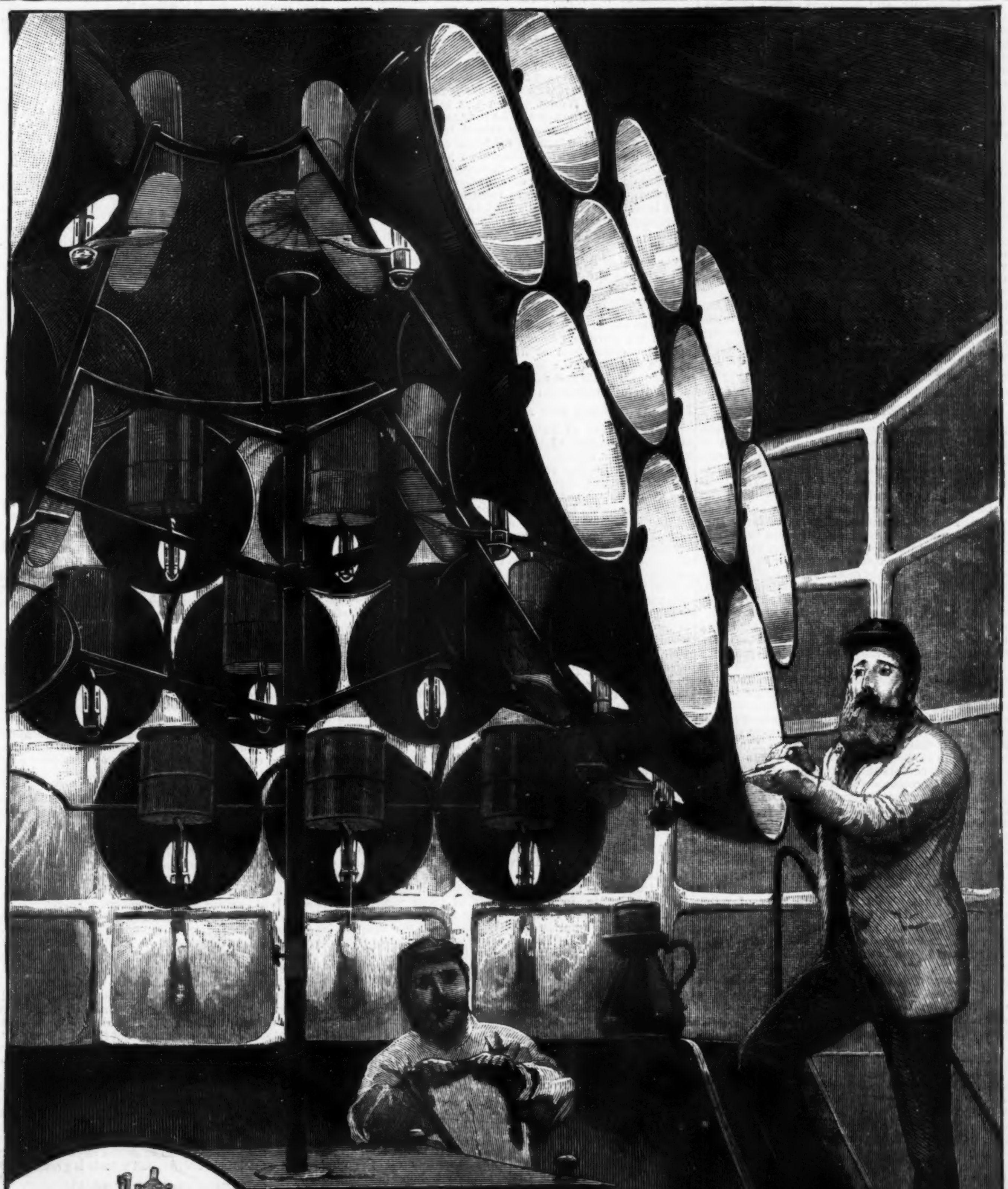


INSIDE A LIGHTHOUSE.—CLEANING THE SILVER REFLECTORS.

INSIDE A LIGHTHOUSE.

AT the eastern extremity of the South Downs, on the Sussex coast, the grand promontory of Beachy Head, near the town of Eastbourne, rises to a height of 575 ft. above the sea. On the Belle Tout Cliff, which projects forward at a much less elevation, stands the lighthouse, erected between 1828 and 1831, that has furnished the subject of our frontpiece. The tower is 47 ft. high, and the lantern displays a revolving light, every two minutes, which is visible at the distance of twenty-three miles. The apparatus here employed is that of the "catoptric" system, in which a revolving frame has a number of large concave reflectors, with an Argand fountain lamp in each, fitted to each side of the frame. The shape and position of the reflectors are precisely calculated to throw the rays of light, in a combined flood of light, upon certain parts of the surface of the sea, and to prevent their being wasted in the sky. The reflectors are formed with a parabolic curve, internally, and are constructed of sheet copper, with a plating of silver on the inner side, which is kept bright and clean by the use of polishing powder (rouge, or tritoxide of iron) and by frequent rubbing with a piece of soft chamois leather. One of the keepers, introduced in our illustration, seems to be engaged in applying the powder with a fine brush of camel's hair. Great care is always taken to prevent dust or grease remaining in the interior of a lighthouse, as it would be apt to spoil the reflectors The Argand lamps have cotton circular wicks of an inch diameter, or sometimes double circular concentric wicks; and are fed with colza oil from a metal canister behind each reflector. This is the ordinary apparatus of a white revolving light; but there is a special arrangement for flashing lights, and for intermittent lights, in which the illumination bursts forth suddenly, and continues steadily for a certain time, after which it is suddenly eclipsed. The ordinary revolving light gradually increases to its maximum and then diminishes to total darkness. Where a powerful fixed light is required, it is produced by an apparatus on the dioptric system, with plano-convex lenses, formed in concentric circles, filling a large sheet of glass, by which the rays of light are refracted and directed toward the sea. This was the invention of the French engineer J. A. Fresnel about sixty years ago; but several improvements and adaptations have since been introduced, and the "holophotal" system of Mr. T. Stevenson has brought it almost to perfection. The electric light has recently been introduced at some of the most important lighthouses of France and Great Britain.—*Illustrated London News.*

A SCIENTIFIC CITY.

WHEN in 1880 the rapidly extending business of the Pullman Palace Car Company necessitated the erection of new works, Mr. George M. Pullman found an opportunity for carrying into effect a theory which he had long entertained. The first question to be decided was as to the location of the shops. A great deal of land was required, and to secure the necessary space in any portion of Chicago would have called for the expenditure of a very large sum of money. More than 3,000 workingmen were to be employed, and if the shops were located in the city, these men with their families would be compelled to live in crowded and unhealthy tenements, in miserable streets, and they and their children would be subject to all the temptations and snares of a great city. Looking at the matter from the standpoint of the capitalist, and from that of the workingman as well, Mr. Pullman felt that it would be better for all concerned if the new works could be established in the country. There was no town already built which commended itself to him. In all to which his attention was drawn there were cheap and shabby houses, numerous saloons, and associations not of the best. To establish the enterprise in one of these would, perhaps, answer the purpose of the company, but the moral and physical well-being of the working people would have to be lost sight of. Unwilling to give up this theory, Mr. Pullman determined to build a town to order. There is a provision in the charter of the Pullman Palace Car Company which prevents that corporation from owning as much land as was required for Mr. Pullman's purpose. To obviate this difficulty, the Pullman Land Company was organized, Mr. George M. Pullman being the President and the owner of the majority of stock.

South of Chicago for many miles the country is very undesirable. Near the lake it resembles the pine barrens of the sea shore. Further inland it is marshy and low. The double tracks of the Eastern trunk lines form ridges through it, and between them the surface water accumulates, or trickles away to Lake Calumet. This is a small body of water which empties into Lake Michigan at South Chicago, and the shores of which are soft and swampy. The object of Mr. Pullman being to find cheap land, he was easily satisfied with that offered to him in this locality. Three thousand acres were purchased, at a merely nominal price! The tract is situated along and near Lake Culumet, and lies on both sides of the Illinois Central Railway, about fourteen miles from this city. To build a city in such a place looked like a great undertaking. But it was exactly what Mr. Pullman desired. He wanted everything to be new and of the best quality. The sewerage problem was the first to be solved. The land was, as has been said, low and level, No natural outlets could be contrived. A great well was therefore dug, and all the sewers of the town, which were quickly built in the most substantial manner in all the streets, were made to center in this cesspool. Simultaneously with the sewers, water and gas pipes were laid. The streets, which are broad and straight, were then laid out and macadamized.

LAYING OUT A CITY.

While this work was in progress under the superintendence of the sanitary engineer employed for the purpose by Mr. Pullman, the architect, Mr. Beaman of New York, was busy with his plans. It is not often that an architect has an opportunity to draw plans for an entire city at once. Mr. Beaman, however, undertook the work with something of the enthusiasm of Mr. Pullman, and catching the latter's ideas was able to transfer them to paper, and take the first steps toward their execution. When the material was at hand special trains with hundreds of workingmen were run from Chicago in the morning, returning with them at night; and in a few months the coming city began to assume shape.

The great shops of the company were erected near the Illinois Central Railroad tracks. These buildings are very substantial, and in some sense ornamental. They are of pressed brick and stone, with roofs of slate, cover fifteen acres, and accommodate more than 2,000 workingmen. South of the works and separated from them by a wide boulevard, along which stand the handsomest houses in the town, lies the city. It is regularly laid out, with wide streets and compact and solidly built houses, all of brick and stone, with handsome lawns, shade trees, and flower beds. These houses are 1,426 in number, and vary in rent according to their size, location, and conveniences. In front of the main building of the company's works, and in plain view from the Illinois Central Railroad, is a beautiful park with a miniature lake, many handsome flower beds, rockeries, solid stone copings, shrubbery, and fountains. South of the depot, which is a fine Gothic structure, is the arcade, and just east is the hotel. The arcade is a spacious and elegant building, which contains all the stores of the city, and the post office, library, theater, bank, and cafe. All the stores and offices face a wide tile-laid interior court, with galleries on the second floor reached by easy stairs. This building cost $300,000, and at night its interior resembles nothing so much as a bazaar or fair. The hotel is a massive building, elegantly furnished, and well kept. The market house, arranged something after the style of the arcade, affords ample facilities for the butchers of the town. The church is a beautiful Gothic structure of stone, with green stone trimmings and a lofty spire. The school house is commodious and sunny. The livery stable has accommodations for scores of horses, and is, besides, the headquarters of the Fire Department. Near the center of the company's works is the huge water tower. Under this is the sewerage cesspool, and in the top is a tank supplied by contract with Lake Michigan water from the Hyde Park Water Works. From this tank water is distributed throughout the town. The sewage which accumulates in this pit at the bottom is forced by means of pumps through pipes to the farm owned by the company, more than three miles away, where it is used for purposes of fertilization. Many misgivings were expressed at first concerning the wisdom of this scheme of sanitation; but its success has been demonstrated; engineers from all parts of the world have investigated it carefully, and have invariably expressed themselves as satisfied of its efficacy. The gas works are situated on the shore of Lake Calumet, just east of the main buildings of the company.

On the 2d of April, 1881, the Pullman shops were started, the great Corliss engine which figured so conspicuously at the Centennial Exhibition furnishing the motive power. With the shops in operation turning out scores of railroad cars of every description daily, the theory of Mr. Pullman was to be put to the test. His theory needs to be understood before his town can be comprehended. The *Sun's* correspondent visited him at his Chicago's office lately and made a few inquiries. Mr. Pullman is calm, dignified, and courteous, a little past middle life, but just in the prime of a wonderfully successful business career.

MR. PULLMAN'S OWN ACCOUNT OF THE ENTERPRISE.

"The building of Pullman," he said, "was undertaken simply as a matter of business. I have little of the sentimental in my nature. I abhor abstruse problems. I can see nothing in this enterprise which is not a matter of finance, pure and simple. I have always believed that there is a great deal of good in human nature; that men naturally prefer to be clean, to have pleasant homes, and to be respected by their fellow men. We are all very largely creatures of our own surroundings and associations. If you take a boorish countryman, with the mud of the farm on his boots, or a city rough, into your parlor, in the presence of your wife and children, he will sit up a little straighter and attempt to be a little more polite than is habitual with him. In a city like this the scarcity of room drives mechanics and other workingmen to the most miserable tenements, where cleanliness is almost impossible, and where, the associations being nearly all bad, they and their families find it almost impossible to lift themselves above the squalor with which they are surrounded. Then, too, the temptations of the city are not to be overlooked. Denied many social advantages, the workingman is apt to drift for recreation into low saloons, where his earnings are spent, and soon his misery and that of his family are increased by his habits of dissipation. Such a man is not more profitable to his employer than he is to himself. Believing these things, as I do, I could not but feel that a place like Pullman would be a good investment. Solely as such was it undertaken. I have not been disappointed in it in any respect. It is a beautiful place, and even on the hardest the effect of the handsome surroundings has been beneficial. On a broad avenue lined with cozy houses, with flowers and lawns on every hand, and scrupulous neatness everywhere maintained, a man of the dullest mind would feel ashamed to appear in public in his shirt sleeves or bare-footed. I have noticed it myself. Some of the families moving into the nice new cottages with their old dirty traps made me feel a little discouraged once, but it was not long before, in the windows of those same houses, pretty flowers were visible, and the appearance of the inmates gradually improved. Everything depends upon one's surroundings. The Pullman enterprise appears to many people to be a very complicated matter. It is not. If it had been, I would not have undertaken it. It was necessary simply that the execution of the plans should be in the hands of one man. I do not pretend to say that some other man could not have succeeded as well as I, but I do maintain that some one man should have the sole directing voice in such an undertaking. I feel that if the building of Pullman had depended upon a corporation or an association it would not have been built. That is, it would not have been built as it is. For instance, I am satisfied that in the matter of the theater nobody would have agreed with me that the expense for that purpose was advisable. As it is, there have been no disagreements, for the reason that there has been nobody to disagree with. The town is as clean financially as it is in every other respect. It has no debts and no mortgages. It is all paid for, and has been from the first.

Usually, when land schemes are set on foot there is a big boom for a while, and then a flattening out. Some people look at Pullman from the cars and say it is pretty, but it won't last. It will last. The works will make it permanent. If for any reason the works were to close permanently, the town, with its fine houses, sewerage, and other conveniences, would prosper as a suburb. I have done everything with a view to permanence, and have made no attempt to create a furor. Having decided to establish our works fourteen miles from the city, the building of houses to accommodate the 2,000 workingmen and their families became necessary. We could not undertake to convey them back and forth, and besides, the location of the shops in the country was for the purpose, in part, of removing our men from the city. We could not expect 2,000 men and their families to live out on the prairie and be contented unless they were provided with the conveniences of modern civilized life. It was here that my theory was put into force. I believe that men who have pleasant surroundings will be better men than those whose surroundings are bad, and that this being the case, the employer will derive a benefit. I have therefore spent a great deal of money in beautifying the town and in providing for the moral and physical development of the people, and it has paid me well. A man who can bring his mind down to understand the simplest business proposition can fathom the Pullman scheme very easily. It is simplicity itself. We are landlords and employers. That is all there is of it."

A CHURCH OFFERED FOR RENT

It may well be asked if Mr. Pullman is not too modest, or if he does not do himself an injustice when he asserts that sentiment has had nothing to do with his great work. The city of Pullman, as it stands, represents an outlay of about $6,000,000. All the buildings in the place are owned by the company. Nobody else can obtain possession of them, for the reason that they are not for sale. They are rented to anybody of good character for sums calculated to return six per cent. on the investment. So many houses were built at one time, they were, of course, put up much cheaper than they could have been constructed one by one. The rents are, therefore, much less than those asked for houses equally good in the city, or even in neighboring towns. To supply so large a population with religious and educational facilities became the duty of the founder of the town, as well as to provide for stores and markets. A fine school house was built, and teachers were employed. A costly church was erected. The arcade and market place were built, and the church and stores offered for rent. Mr. Pullman knew that the church was a better one than any new society could afford to occupy. He built it expensively, however, for he believed that a congregation would be found able to pay for it. The rent is $50 per month. It has not been taken yet, but there are several church organizations, and there is considerable rivalry among them as to which will obtain the prize. If other churches are needed, they will be built by the company.

Feeling that the town would attract a good many visitors, Mr. Pullman built the hotel. It is owned and managed by the company, its landlord, so called, being merely an employe. The Fire Department is owned and operated in the same way, as also are the livery stable, the theater, the public library, and every fixture of the town. A stranger arriving at Pullman puts up at a hotel managed by one of Mr. Pullman's employes, visits a theater where all the attendants are in Mr. Pullman's service, drinks water and burns gas which Mr. Pullman's water and gas works supply, hires one of his outfits from the manager of Mr. Pullman's livery stable, visits a school in which the children of Mr. Pullman's employes are taught by other employes, gets a bill changed at Mr. Pullman's bank, is unable to make a purchase of any kind save from some tenant of Mr. Pullman's, and at night is guarded by a fire department every member of which from the chief down is in Mr. Pullman's service. Everything is first class in its way. The library has 10,000 volumes, and is the personal gift of Mr. Pullman. The theater, which, like the library, is in the second story of the arcade building, is one of the most elegantly arranged places of amusement in the world. Its prices are reasonable, and it is open to dramatic and literary entertainments of the best class only. During the first six months that the library was open seventy-six per cent. of the books taken out were on historical, biographical, or scientific subjects.

A CITY WITH NO CORPORATE GOVERNMENT.

Although the city has a population of 7,000, it has no government save that which is exercised in common over the entire township, county, and State. In other words, there is no corporate government. No arrest has ever been made within the Pullman tract. There are no policemen or constables; no justice's court, no aldermen, no public functionaries of any description.

"How in the world do you govern these people?" is a question often asked of Mr. Pullman.

"We govern them," he says, "in the same way a man governs his house, his store, or his workshop. It is all simple enough, when you come to look at it."

So it seems. A man going there to live applies for a house to the superintendent, who draws up a lease which may be canceled by either party on ten days' notice. The company will not disturb him if he is a good citizen, and he may keep his house as long as he pleases, provided he does not sell liquor. On the other hand, if he is dissatisfied and wishes to leave, he can do so at any time, and is not encumbered with a lease running a year or more. No liquor is sold in the town. The only law against it, however, is an unwritten one whereof Mr. Pullman is the author. To provide healthful amusement and recreation for the people, Mr. Pullman has fitted up handsome boat houses on Lake Calumet, and this beautiful body of water is nightly covered with boat loads of pleasure seekers. There are many organizations among the workingmen, including a debating society, a literary association, a brass band, a base ball club, and others. It is the desire of Mr. Pullman to encourage all these as much as possible. He feels the need of a newspaper in the town, and intends soon to establish one. It will be edited and managed by his employes. He has no selfish purpose in establishing this journal, his sole motive being to give the people the news at little expense and afford them certain amusement. He thinks, also, since they have organized so many societies, that it will be very entertaining and instructive to them to have their proceedings reported.

Any mere sketch of this town must be imperfect. There are so many things to write about that it is impossible to cover them all. The idea uppermost in one's mind after seeing and understanding the place is, perhaps, that the humblest citizen there is in the enjoyment of many advantages which only wealth can supply, and that although far from a capitalist himself, he suffers few of the inconveniences of poverty There is no extortion anywhere, and the fullest freedom consistent with good morals is granted.

OTHER PROJECTS OF MR. PULLMAN.

Mr. Pullman has many projects for the future. He is now thinking of establishing in the town new works which will give employment to women and girls. Just what these will be he is not prepared as yet to make public. He believes, however, that the place will afford an excellent home for women who are dependent upon their own labor for a livelihood, and that, with some sort of a manufacturing establishment in which they can be profitably employed, very many of them can be made to see that it is to their advantage to settle there. The Pullman's Land Association has purchased large tracts of land adjoining the site of the town, and it is the intention of Mr. Pullman to lay out streets and alleys, and give industrious workingmen an opportunity to purchase lots on which to erect homes for themselves. Certain restrictions will be placed on men contemplating improvements of this kind, but they will not be such as to impair the value of the property to the owner. Mr. Pullman informed the *Sun's* correspondent that these lots would be sold to workingmen this year for $800. When paid for, the company would put up a house and sell it to the employe at actual cost on easy

monthly payments, amounting to very little more than the ordinary rent. It is expected that many outsiders will take advantage of this offer, and that the number of houses built under such conditions will be large. This suburb of Pullman, as it is called, will be supplied with all the conveniences to be found in the parent town, and will be connected with Chicago by means of a railroad to be owned and operated by the company. Several large manufacturing plants have been established near Pullman, and others are contemplated. The Allen Paper Car Wheel Company has extensive works in Pullman itself, and its buildings form no insignificant part of the large edifices there to be seen.

NIGHT SCENES IN MR. PULLMAN'S CITY.

No man who has not seen the city of Pullman at night can say that he fully comprehends the social and industrial problem that has there been solved. The majority of writers who have attempted to describe the workings of this remarkable town have contented themselves with brief visits in the daytime, when the men were all employed in the shops, the children at school, and the women engaged with domestic duties. Under such circumstances the architectural peculiarities of the town may be conveniently viewed, and in a general way the scope of the place may be comprehended, but there is a much more important and certainly a vastly more interesting side of the picture.

The town would have been built in vain if there could have been found no people who would live there contentedly. The scenes which the streets and public resorts of the village present after nightfall are entertaining in the extreme, and prove perhaps more conclusively than anything else the fact that Mr. Pullman's estimate of human nature is far from wrong. After the evening meal the people make their appearance on the streets. They are presentable almost without exception, and most of them are surprisingly neat in their dress and circumspect in their manners. The women and children, in clothing and deportment, present such a striking contrast to the people of their class in the noisy and dirty city that, having seen the two modes of life, an observer might be pardoned for doubting that Pullman is made up almost exclusively of mechanics and laborers and their families. In gay groups they assemble on the streets, or promenade, visiting the arcade, the library, the post office, and the stores. In summer there are boating, lawn tennis, base ball, cricket, bicycling, and a dozen other diversions for the men and boys, in which the women also take an interest.

A TALK WITH ONE OF THE INHABITANTS.

Standing in front of the hotel the other evening, watching the merry throng go by, I fell in with a sturdy young fellow who looked as if he had seen something of life, and I asked him how he liked it in Pullman.

"I like it," he said promptly, "better than I can very well tell."

"Are you married?" I asked.

"Yes, and that's one reason why I like it. I am married and have two little children. I was brought up on a farm in York State, and, though my parents were not rich, we had things decent and comfortable. There was always plenty of good, wholesome food, pure water, clean clothes, and fresh air where I was born and raised, and I got used to those things. Well, when I first worked in a shop in a big city I was single, and, as I earned good wages, I got along pretty well, but when I married I found that we could not board, and when it came to keeping house in Chicago, on my wages, the style we had to put up with did not suit either of us at all. We had a little cottage on the west side, but there was mud on all sides of us, two beer saloons within a block, clouds of soft coal smoke, poor sewerage, villainous water, and everything else that was bad and disagreeable. After our little girls were born I began to feel uncomfortable, and my wife worried about them. There were many deaths daily in our section of the city from diphtheria and scarlet fever, and we found it next to impossible to keep anything clean. I had about made up my mind to take what little money I had and go West and locate on some Government land, when I chanced to read in a paper something about Pullman. I lost no time in investigating the town. I found I could get work here at wages fully equal to those paid in the city, and that I could rent a whole brick house with good water and drainage, and pleasant surroundings, for $15 a month, the same money I had paid in the city for a miserable shell of a tenement. We lost no time in moving here, and we have hardly been out of the town since. We have a clean and comfortable home and plenty of pure air. My children are healthy, and as for my wife, she has seemed like a different woman since we came here. There they are, now," he said, as he begged to be excused, and stepped up to a neatly dressed young woman, who held a bright and attractive little girl by either hand.

Presently they passed on, and the mechanic, resuming his place by my side, said: "The only thing I am afraid of is that this thing won't last. Of course there is no danger of its coming to an end, but somehow it seems too good to be true. You see there is no liquor here, and therefore the men are nearly all industrious, sober, and cleanly. There are churches made up of such people as I am, so we do not feel out of place when we go to service. There is no snobbery and no wealth. Then we have many social, literary, and sporting organizations, which afford us nearly all the amusement we want; but the theater is open frequently, and such of us as want to go are always certain of finding a decent and worthy show. The library, too, is a luxury which only those who like to read but who cannot afford to buy books can understand. You see, I like the town. I shall stay here, and so will my family."

WHY THE PEOPLE ARE CONTENTED.

I asked him if there were any offensive restrictions in force, and he answered:

"Why, bless you, no. It is just like living in any other town, only you won't find anywhere else on this earth another place where all the advantages of a large city are combined with those of a rural village. There are no rules and regulations which worry a decent and honorable man. The company owns everything here, of course, but in every branch of the business it is represented by an employe, and we get to feeling after a while that the man who runs the hotel is the actual proprietor, and that the man to whom we pay our gas bills is the real owner of the gas works. The company takes no advantage of the men. If it did, of course, they would not stay here. This whole scheme is a business venture on the part of the Pullman Company, and it pays them. The men stay here because it pays them to, and yet the most of us do not lose sight of the fact that the originator of the scheme, George M. Pullman, was governed by philanthropic as well as interested motives."

I said to him, "Of course, out of all the men employed here, there must be some who drink. Where do they get their liquor?"

"Oh, you can see them any evening cutting off across the prairie to the neighboring suburbs of Chicago. There are not a great many of them, but there a few who always slip away, though you can bet their families had rather they would stay here. There is nothing to prevent the whole town going over to Englewood, or to the city, for that matter, and getting drunk, but you see we do not care to do it."

Everything about the place and its people indicates comfort. The women and children with whom I conversed expressed themselves without exception as delighted with the town. I heard of a few instances where women fond of city life and attached to friends who lived in Chicago complained of the dullness of the town, but the probability is that their dissatisfaction will not long continue.

OPINIONS OF THE ENTERPRISE.

Several men whom I asked for opinions concerning the Pullman experiment replied in monosyllables, but in the tone of none could I detect an inclination to find fault with the town or the theory on which it was founded. Even the men who roamed off across the prairie in search of liquor, on returning with heavy feet late at night had no word of complaint to offer except one, and that was that it was apt to be a very long time between drinks when a man had to walk three miles for them.

The town is the pride of Mr. Pullman, and he continues to give much of his time and thought to it. When it was first opened he sent his butler to take charge of the hotel, and his governess to teach the school. So in other departments of the work he trusted the initiation of the enterprise to faithful servants long in his employ, who knew and fully understood his views and wishes. Thus every part of the vast machine was put in running order under his own eye, and, to some extent, has so continued.

"Does it pay?" the correspondent asked of Mr. Pullman, at the close of the interview previously mentioned. The reply, while not as explicit as might have been wished, was, nevertheless, satisfactory. "The aim was," he said, "to realize six per cent. on the investment. We have done that, and are satisfied."

HANDWRITING.

FEW pause to consider the multifarious agencies concerned in the production of writing, both as regards its mere manual execution, and the nice adjustment of mental and physical processes needful for its best exhibition. Dr. Bianchi touches upon a novel and interesting theme in a recent article on this subject, in *Il Pisani Gazetta Sicula*, which has been translated for the *Alienist and Neurologist*, by Dr. Workman.

The first characteristic which arrests attention from its universality is the use of the right hand, which has been attributed to the greater activity of the left lobe of the brain, "to preponderance of structure, result of habit, or education;" secondly, we notice the differences of direction, the Asiatics writing from above down from left to right; the Semites and Aryans write in lines one below the other, the former following a centripetal system from right to left, while the latter adopt a centrifugal method from left to right.

The authors claim that to write it is necessary to see, hear, and understand; the optic nerves awake the motor cells in connection with the muscles of the hand, the auditive nerves do the same, and intellective currents may also originate motions of the fingers in writing. In case of the blind the sense of touch replaces sight. As we have no parallel action on the part of the lower animals, comparative physiology will help us very little in an examination of this subject; it is only "the exact clinical study of cases of central lesion with alterations of written language which can throw sufficient light on this phenomenon." The act of writing is, indeed, as expressed in technical terms, surprisingly complex; first the pen is seized by the flexors of the first three digits, "next the whole hand has to join in the action of the flexor and the interosseous muscles." Three groups of muscles engage in this familiar exercise, the interosseous, which hold the pen and trace the letters, the long extensors, which aid them in the more extended motions and half turn the hand, and "the long flexors with the muscles of the hypothenar eminence," which oppose the interosseous, serve to steady the hand, and help in the formation of letters which are extended below the line. Or more simply, the act of writing implies a fixation of the hand and pen, and the formation of letters.

Alterations in handwriting are classified as *mechanical* and *psychical*, the former again separated into *ataxic* and *tremulous*, the latter into *conscious* and *unconscious*.

Ataxic writing is exaggerated, crude, and affluent, abounds in enlargement of letters, long tails, and irregularities, is the writing of children or those learning the art; tremulous writing is wavering and unsteady, and prevails in old age. To these two are added the *reverse chirography*, which is the left handwriting which but lately has attracted attention. "It consists in tracing the letters from right toward left with the upward slope to this side, so that in order to read it we have to hold the sheet before a mirror."

Doctors differ as to the pathological character of this form of handwriting, some regarding it as normal, being the natural writing of the left hand. It has been discovered in some of the writings of Leonardo da Vinci, whose right hand was paralyzed, and is described in this case as "the necessary consequence of writing with the left hand that obliged Leonardo to execute the reversed form of writing."

Then we find *agraphia*, which is partial or complete as the patient is able to execute only right or circular lines, or cannot trace a letter. True *paragraphia* consists in ungrammatical construction, omission of words, etc., of which the patient is conscious, but powerless to remedy.

Examining the obvious and patent facts about handwriting and its irregularities, the author concludes that we see from childhood to manhood a growing perfectionment of the control of the centers which regulate writing over the process, and from prime to old age on the other hand a constant decrease of power accompanied with general enfeeblement, loss of strength, accuracy, and beauty.

Ataxic writing described above occurs "in cases of central or peripheral lesions of the nervous system, which impair the co-ordination of the motions of the different muscles that accomplish the act of writing." It is also seen in convalescence from typhus, diseases of the cerebellum, poisonings by alcohol or chloral. Tremulous writing accompanies *paralysis agitans*, and indicates at times the approach of paralysis. It is found in those poisoned by alcohol, morphine, nicotine, and chloral.

Agraphia is observed in the last stages of paralysis and disseminate sclerosis and in cerebral lesions. It may result "either from paralysis of the muscles which serve in writing or from destruction of the cerebral center or centers that preside over writing."

Hemiplegia produces the *reverse chirography*, as was observed by Buchwald. This is also called *lithographic*, because lithographers write in that way on lithographing stones, and about it much discussion has risen. It is pathological, but also can be shown and occurs with sound persons. It may be regarded as the normal left handwriting, being centrifugal as regards the axis of the body, and may be associated with a lesion of the left hemisphere of the brain by which the impressions and images of the right assume control, and being, as Dr. Ireland suggests, the opposites or reversed, or as it were negatives of those of the diseased left lobe, initiates an action from right to left instead of the usual direction.

Dr. Ireland says that in a school of 100 pupils of both sexes only five in writing with the left hand gave the lithographic form, and these all used the left hand habitually. They did not realize their writing was abnormal, and wrote rapidly and easily. In another school of 134 only three wrote reversed. Of course, in these cases it had no pathological significance, but resulted from the superior activity or receptivity of the right lobe and the inertness of the left.

Vogt has shown that reversed writing with the left is much more intelligible than reversed writing with the right hand, which goes to prove its natural conformation. Instances are recited confirming this conclusion.

The author remarks upon the writing of the demented without eliciting any facts of much interest, as he reiterates the familiar fact that the handwriting in its execution and grammatical form reflects the species of dementia from which it springs. It is, however, useful to have suggested the examination of the handwriting of either the sane or insane, for prognostications of approaching states, or of a return to normal conditions.

In conclusion he remarks that "the best treatment in cases of mechanical alteration of the writing is galvanization of the brain, good intellectual exercise, and a well-directed education of the hand.

MEMORY.*

By DR. R. WOOD BROWN.

THERE is no subject of Nature so interesting as psychology. Man, ever since his creation, has been trying to penetrate the mystery mind, and after thousands of years the subject is just as obscure as it was to the first investigator. The physiologist alone has been rewarded, the psychologist is still striving to wrest from Nature this her most subtle secret.

We shall, this evening, show how memory acts from a physical standpoint, also the theories advanced explanatory of the action of the mind. We may say that memory is an attribute of the mind, but it would be more correct to say that they are synonymous, and that thought and imagination are attributes of memory.

Science has not been able to explain the causation of memory, but her votaries have done much toward explaining physically the action of it. It must be remembered, that while the data are voluminous, and the number of nerve fibers and cells estimated, the conclusions arrived at are in many cases hypothetical as regards the action of memory. The metaphysician has done but little, the physiologist almost everything.

The most succinct definition of memory I find is Ribot's. He says that: "Memory is the retention of certain states, their reproduction and their localization in the past." We certainly cannot wish for a more clear analysis. Physiologists have located the intellect in the gray matter of the brain, a thin crust one-tenth of an inch thick and composed of convolutions and sulci. It has been estimated that there are about 300 square inches of gray matter upon both hemispheres. This crust is supported by white matter which is a mass of nerve fibers, and makes by far the largest part of the brain. The gray matter is composed of cells and fibers, which according to Mr. Bain number about one billion and five billions respectively. These cells and fibers are the factors of memory, and for distinctiveness at this time I will denominate them memory cells.

An acquisition is a certain thing acquired or learned, and in a richly endowed and highly retentive mind of, say, two hundred acquisitions, each grouping would require five thousand memory cells and twenty-five thousand fibers. It must be remembered that the brain, besides having memory cells and their associated fibers, is also a sort of battery to furnish power for movements of muscles, acts of energetic volition, and also of feeling.

The causation of memory is just as mysterious as that of life. Memory exists, and that is the sum total. Life was brought into existence, either from a fortuitous combination of oxygen, nitrogen, hydrogen, and carbon, making protoplasm, which became animated, or by a special divine act of creation. Scientists generally agree that all life must have antecedent life, which to my mind is the only proper solution of biology.

The two most plausible theories which account for memory physically are the residuum and vibratory. According to the former theory, when an impression is received by a cell, a residuum is left, the result of a chemical change or decomposition of its protoplasm. When we look upon a pear, certain cells respond to the excitation of the impressions of contour, color, size, and stem; the result of this responding is a residuum. If these impressions are repeated often enough, a permanent residuum is formed and we have a memory cell. Decomposition is the act of separating the constituents of a compound. These constituents would be elementary bodies, but in the above cells the decomposition is said to leave a residuum, but no explanation is given as regards the action of the residuum after it is formed. I am at loss for any logical deduction whereby I can understand the action which goes on in the cell after it has been completely decomposed and a permanent residuum has formed, which under this theory I would call a memory cell. The residuum theory leads us to the time when the cell becomes permanently changed, but does not enlighten us upon its subsequent action.

The vibratory theory explains the physiological action of memory in a very satisfactory manner. If we look at the pear, certain cells vibrate from excitation, resultant from the impression. We do not have, in this instance, any decomposition or residuum, simply a vibratory movement. The cell remains the same, except the molecular arrangement. When the impression ceases, the cells cease to vibrate, and obtain a period of rest which is essential to memory. It will be noticed that the vibration of a cell is clear to the mind,

* Read before the Kansas City Academy of Science, December 21, 1883.

because it acts in its entirety, rests, and vibrates again to the same impression; each vibration fixes permanently its peculiar movement, and we have a cell which vibrates to no other impression, and the result is a memory cell. This is much better than the residuum theory, which leaves a residuum after every cell vibration and eventually a permanent one.

When an impression is received upon the retina, tympanum, tongue, fingers, or olfactory bulbs, it is conveyed by proper nerve filaments to cells in the gray matter of the brain. These cells vibrate from excitation, and undergo a change, say that of molecular arrangement. If this impression is repeated often enough, the molecules are permanently changed, and we have memory cells and remember the impression. If, on the other hand, the impression is made but once, and then not violently, the cells assume their first condition and we forget the impression, it passes from our mind. In this connection let me say that in the true sense we do not see an object, hear a sound, feel a substance, smell an odor, or taste edibles; we simply become conscious of the impression when they irritate to vibration the cells in the gray matter. These impressions cause different cells to vibrate the same to the same excitations, which allows differentiation, and memory is the result. If different cells responded to the same impression, there would be no permanency, consequently no cognition.

Why do the same cells vibrate to the same impression? The most plausible explanation is molecular change. If we strike a bar of steel upon the end with a hammer, we can produce a magnet. The blow causes a change of molecules in the steel, and polarizes them. Whether the molecules of a cell are simply changed, or polarized, is hard to determine, but that some change takes places by vibration is evident from the fact that we remember more easily where the impression is received many times.

If the molecular theory is correct, and every substance is composed of molecules, the whole body of cells in the gray matter would be no exception. Some men of learning say that the molecules of the body are polarized in health, and when disarranged disease is the result. If this is true, and nervous force electricity, and the brain the battery, why not say that the change in a memory cell is molecular?

Why does the same cell vibrate to the same impression? Force or motion travels in the direction of the least resistance. When an impression is carried along a nerve fiber, there is a certain amount of resistance, and every impression weakens its power to resist, and each succeeding impression travels along the fiber which is attuned to it and has the least resistance. If the same impression is carried on the same nerve fiber, it must necessarily reach the same cell, which vibrates according to its molecular change, and we become conscious of the impressions. I would, in this connection, say that repeated impressions are not always necessary to produce a memory cell. A sudden violent excitation will cause a permanent change in a cell. We all have experienced sudden impressions which we have never forgotten, and never have felt but once.

To remember is to recur almost instantly without exertion of will, to recollect is to recall by associations, to gather ideas step by step until the impression sought is brought to mind. We recollect by association, by a group of cells vibrating which excites another and so on. According to Bain, there are about one billion cells and five billion fibers. These fibers connect cells and consequently groups. It will be readily understood how this occurs, if we bear in mind how we think; how one thought brings another into consciousness. We smell a rose, its odor excites certain cells; through fiber connections other groups are excited to vibration, and we are conscious of events where the rose assumed a prominent part. We see a face which recalls the name and peculiarities of the possessor. We see a house, and recollect the persons living therein. The house causes an impression which excites to vibration a group of cells, which in turn brings other groups into activity and we know the occupants. Most of our thought is through association, comparatively little that is instantaneous.

In remembering, time and space are of little value, but they are essential to recollection. When we indulge in retrospection, memory carries us back weeks, months, and years. We cannot recollect without time and space. The time is the present, space the period between the occurrence and the present moment.

We have a conscious and organized memory. When we perform an act with a distinct end in view, it is the result of conscious memory. When a beginner is learning to play upon a piano, every note is struck by the effort of the will, and therefore conscious. In setting our watch, we do it consciously; we have found the correct time and our mind is on the act, and we turn the bands carefully until our aim is accomplished. Therefore every act of will power is the result of conscious memory.

Intensity and duration are indispensable to conscious memory. If one of these conditions be wanting or any other unknown to us, then consciousness (a part of the whole) would disappear, and that which would remain of the fact is organized. Intensity is a degree of concentration which may vary, owing to the striving of our states of consciousness to supplant one another, and victory results either from the superiority of one or weakness of the other. Duration is the period between the impression and consciousness of it. Ribot says it requires 0·16 to 0·14 of a second to hear; 0·21 to 0·18 of a second to touch; and 0·20 to 0·22 of a second to see. This would indicate that the expression, "quick as thought," is a mere figure of speech.

The acts of organized memory are performed unconsciously, involuntarily. The odor of food will sometimes cause an increased flow of saliva. When we were learning to walk, our steps were taken with hesitancy and deliberation—consciously; now we walk without knowing it, our conscious memory, through continual repetition, has become organized. If we meet an obstruction on the sidewalk, we unconsciously move to one side to avoid it. This is the result of experience. We know intuitively that, if we do not turn, we will run into the obstruction. Intuition and organized memory are to my mind synonymous. We raise food to our mouth without consciousness; this is the result of habit. Habit is resultant from frequent repetitions, which produce organized memory. Upon reflection we will find that comparatively few of our acts are conscious. Consciousness is a narrow wicket through which we are connected with the outer world.

I spoke of a group of cells always vibrating to the same impression, and another argument in favor of that statement is the weariness which ensues upon protracted vision, hearing, taste, etc. If different cells responded to the same impression, there would be no weariness. Cells do become tired and refuse to act. If we look upon one color continually it becomes blurred, one continual sound becomes indistinct, the odor from a flower is at first acute, afterward less fragrant. This would indicate two things: first, that the same cells respond to the same impressions; second, that memory cells must have rest. This rest is given by exercising different faculties and by sleep. But even in sleep this result is not always attained, for we often dream, and dreaming is cell activity during sleep. This is proved by the fact that we never dream of anything but past events.

Physiologists have proved that during sleep the brain is pale from want of blood, but if the sleeper dreams it is a brighter red. This would indicate an activity of the brain during dreaming. One of the peculiarities of dreaming is the extremely brief period which is required, also it takes no note of time or space. A drop of water has caused a dreamer to travel thousands of miles, to drown in a lake and to wake him up. A gentleman in this audience once dreamed "that he was walking through a street, and stopped before a hardware store in which were stoves arranged in tiers one above another; while looking at them they fell with a terrific crash to the floor." Another student throwing a box down stairs caused this dream and awakened the dreamer at the same time. Dr. Carpenter relates the case of a clergyman who fell asleep in the pulpit, awaking with the idea that he had slept for more than an hour; but on referring to his hymn book, he found that his sleep had lasted through the singing of a single line.

SAGNES' MACHINE FOR MAKING MOULDS FOR OBJECTS IN COPPER AND BRONZE.

FOR making moulds of objects in copper and bronze that are not of very large dimensions it is customary to employ metallic flasks, in which, by means of a special kind of sand, matrices are made of the objects to be cast. For a long time, such moulds were made by hand by special workmen; but recently machines have been devised for doing away with manual labor and for performing the operation mechanically, although such apparatus are not as yet very numerous. Some of these, of the type of stamping presses, receive motion through the intermedium of an endless screw, while others are actuated by a connecting rod and winch. These latter are, in our opinion, the best, because they permit of more speed and since in the industries "time is money." It is to this type that belongs the machine which we shall now describe, and which is the invention of Mr. Francois Sagnes. This machine, which is shown in the accompanying engraving, permits of manufacturing much more rapidly than can be done by hand (and consequently much more economically) moulds for objects of small size, such as sheathing nails, rivets, fuses for shells, small cocks, hinges, etc. It is especially useful as regards the moulding of interchangeable parts—that is to say, those that have to be produced in large quantity. A special arrangement is used for nail mould making, a peculiar chair being adjusted to the machine for that purpose. For these kinds of moulds a different chair is employed.

We shall first describe the arrangement adopted for making moulds for nails.

The machine, in its appearance, reminds one of a mortising and drilling machine. It consists of a vertical slide, A, B, C, which has an alternating up and down motion, and which carries at its lower part a plate, AB, designed for compressing the sand in the flask, C. This latter rests upon a moulding table, P, which carries all the nail heads. These heads are hollow and are traversed by the models of the shanks, these models being fixed upon a lower plate, P', that can be raised or lowered so as to cause the shanks to traverse the heads, or hide them below. The plate, P', is fixed upon a rod, T, which is guided below in its vertical motion, by a piece, G. A small sleeve, M', fixed upon this rod, permits of regulating the descent of the shanks; the piece, T, is actuated by the lever, L, through the intermedium of the gearing, E, and the rack sleeve, M. The machine is driven in the following manner: the pulley, F, receives its motion through an endless belt and causes the revolution of the pinion, P, which gears with the toothed wheel, E, that is mounted loosely upon the shaft, A', but that is capable of following the motion of the latter on gearing with a clutch-box, D', this latter being fixed upon the shaft and being capable of moving in a longitudinal direction. The gearing of this coupling sleeve, D', with the wheel, E', is effected by hand, by means of the lever, L', the connecting rod, B', and the lever, D, and by the workman acting upon the lever, L. At the extremity of the shaft, A', there is mounted a plate, H, with one point of which is jointed the connecting rod BB', whose upper portion is fixed to the slide, ABC, which, by this means, is given an up and down motion. The mechanism is completed by a ratchet wheel, R', and a click, R', which prevent a backward motion. Such is the arrangement that is employed when it is desired to make moulds for manufacturing nails.

The operation of the machine is as follows: The workman raises the lever, L, so as to cause the shanks or bodies of the nails to pass through the heads, and then stops it by pushing the rod, Q. He then places the flask, C', upon the table, P, and fills it with sand by means of a box provided with a slide and containing exactly the quantity necessary. He now throws the machine into gear so as to press the sand compactly into the flask, and afterward throws it out of gear by pushing back the lever, D. After this he causes the nails to descend, and then has nothing more to do but remove the frames; the moulding is completed.

The arrangement which we have just described, and which is especially for nail mould making, permits likewise of

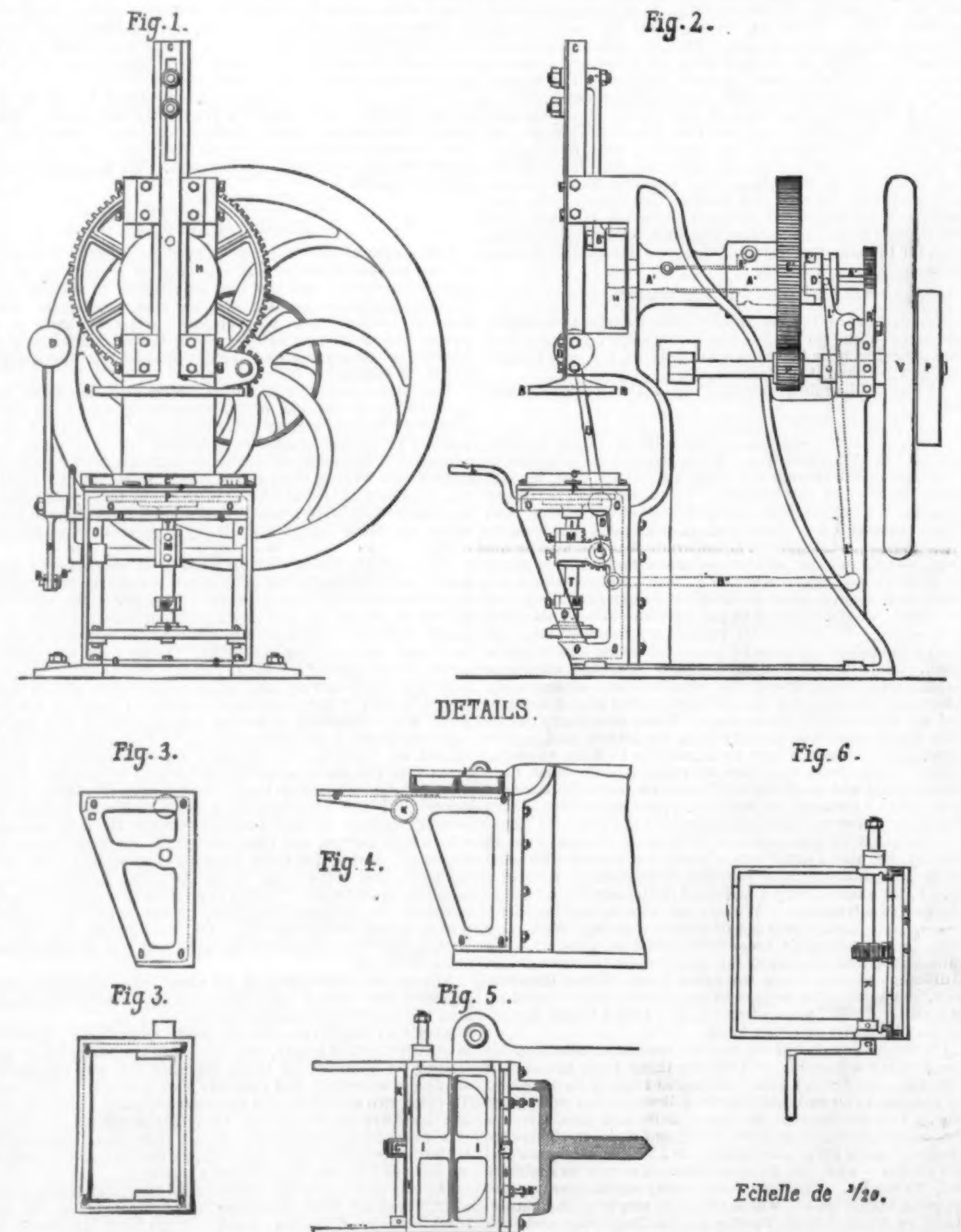


FIG. 1.—Front View. FIG. 2.—Side View. FIGS. 3-6.—Details of Moulding Table.

MACHINE FOR MAKING MOULDS FOR OBJECTS IN COPPER AND BRONZE.

moulds being made in flasks having two faces. But if it be desired to have recourse to moulding upon the follow board, which is very advantageous for all pieces that can be moulded in green sand, it is necessary to modify the machine a little, and employ a movable chair that may be drawn forward so as to permit the frame to be turned around. In this case, the type shown in Figs. 4, 5, and 6 is employed. The moulding table, J, is fixed upon the plate, I, of the chair, O, I being capable of sliding backward and forward upon the latter through the intermedium of the rack, M, and pinion, P″ actuated by the winch, C‴. The table, J, is regulated beneath the compressing plate, A B, by two screws, B′.

This machine permits of considerable economy being realized over mould making by hand; and, being well constructed, it gives, when properly operated, excellent results.

It is especially where making moulds with two machines combined is concerned that the advantage is great; for, in this manner, there may be made 500 moulds per day, with two workmen and one assistant to run the machines.—*La Genie Civil.*

MEINESZ'S COMPRESSED AIR DREDGING APPARATUS.

A FEW dredging experiments have been made, especially in England, Holland, and America, with apparatus designed for digging up alluvion, dissolving in water the materials of which it consists, and giving these up to natural currents when the latter have their greatest strength. Such experiments, however, have not given satisfactory results, since the materials thus dredged were lifted but to a small distance from the bottom from which they had been extracted, and thus almost immediately settled back again in the same place. Although this mode of dredging had therefore to be given up, it has recently been successfully taken up by Mr. Meinesz, who employs compressed air for forcing to the surface the material that has been detached by means of a kind of harrow, in order to put it thus in contact with as great a number of molecules of water as possible and to give it a velocity in a direction opposite that of gravity. Once raised to the surface of the water, the sands are carried off by the current to distances which vary according to the swiftness of the current and to the depth from which they have been dredged. The whole question, then, resolves itself into a study of the direction and force of the current, so that the deposits shall be borne away as far as possible from the channel that it is desired to excavate.

Mr. Meinesz was recently authorized to make experiments with his apparatus upon the sand bank which is situated in front of the east stockade of the port of Nieuport, the experiments to be under the surveillance and with the concurrence of the Belgian State engineers. With this end in view, buoys were placed in such a way as to mark the field of operations (which measured about half a hectare), and soundings were made in order to perfectly determine the form and extent of the sand bank.

According to the memoir presented by Mr. De Cazenave, the reporter of the committee on experiments, the apparatus was operated on the 24th of May last during 3 h. 23 m. at rising tide, and the current then carried off the sand that had been raised to the surface, in a direction from east to west and with a velocity of at least one meter and a half to two meters per second. The apparatus was operated against the current, and the velocity communicated to the water by the helix of the boat, joined to that of the current, carried off the excavated sand with still more force. So, despite the depth to which the apparatus was immersed (3·57 m.), the sea water was colored yellow in the direction of the boat's track and over a distance so great that it was impossible to estimate it. While the experiments lasted, the boat passed fifty times from east to west between the buoys. The next day, at rising tide, the state of the sea permitted new soundings to be made, when it was ascertained that the quantity of sand that had been raised was 775·5 cubic meters. The work, moreover, was not performed very regularly, owing to the inexperience of the crew and to the fact that the buoys interfered with the boat's running.

The accompanying figures represent the details of the dredge used in these experiments.

A small tug of 30 tons burden, drawing 8 feet of water, and propelled by a 30 H. P. engine, carries a capstan whose chains are connected with the frame of the apparatus. This latter consists essentially of a barrow, B, fixed to a strong iron frame, *a* (Fig. 2), which is carried by four wheels 0·80 m. in diameter and of the same width of felly so as to permit the vehicle to make its way along the bottom without sinking into the sand or mud. The harrow, properly so called, consists of toothed pieces of steel firmly fixed to the frame, and having an inclination of about 35° and a length of 0·28 m., with a projection of 6 cm. beyond the lower point of contact of the wheels, so as to remove from the alluvion a slice of corresponding thickness. On the side of the bearing crosspiece, A, and above the blades, there is a pipe, C, which contains along its upper side 340 apertures 1 mm. in diameter. This conduit is put in communication, by means of two rubber tubes, C′, with a compressed air pump, which is stationed near the boat's engine, and which gives per minute a volume of air equal to 3 cubic meters, with a cylinder 0·25 m. in diameter and having a stroke of 0·3 m.

The frame of the harrow is suspended by means of four chains which wind around a steam capstan placed in the fore part of the boat, and is, moreover, held at an equal distance from the transverse axis of the boat by two pieces of iron, D, which are jointed at their extremities and are designed for towing the harrow.

These arrangements have not been decided upon definitely, but only as a matter of experiment. In order to get up a dredging boat for regular service, certain parts of the whole would have to be modified; for example, the air pump would have to be independent of the boat's motion so that the pressure of the air on its exit from the orifices of the scape pipe could be regulated at will. It is thus difficult, under the circumstances under which the experiments were performed, to estimate the cost of dredging per cubic meter. To do this it would be necessary to work regularly with a boat having sufficent power (100 H. P., for example), and a dredging apparatus established under proper conditions. Still, it is of interest to give the preliminary estimate, which is certainly above what the real cost will be. Now, Mr. Cazenave fixes it that the 775 cubic meters removed in the experiments described above would have cost 105 francs, in supposing a work of 180 days per year, or about 0·13 franc per unit and for an operation of 3 h. 23 m.

This cost, which is very small as compared with that attending the use of such apparatus as are at present employed, would become, then, almost insignificant in a regular enterprise and with a well studied installation. Thus, supposing the experiments had been made for 12 hours (6 hours at each tide), the quantity removed would have been, at the same proportion, 2,700 cubic meters, and the cost would have only amounted to 0·05 franc.

According to the conclusions of Mr. Cazenave's report, the Meinesz compressed air dredge is applicable only in places where the bottom is formed of sand or soft material easy to put in suspension, and where the currents are usually or periodically strong. Under such circumstances it is called upon to render undoubted services and to cause a considerable reduction in the cost of keeping ports and the mouths of rivers in proper condition. The apparatus offers the further great advantage that it can be adapted without much expense to existing tugs, thus permitting of these latter being utilized when they have nothing else to do.—*Revue Industrielle.*

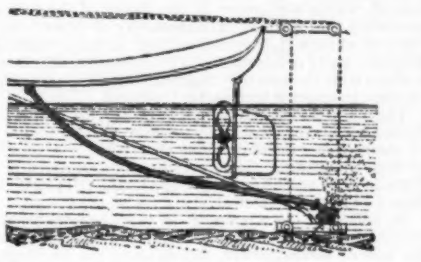


FIG. 1.—General View.

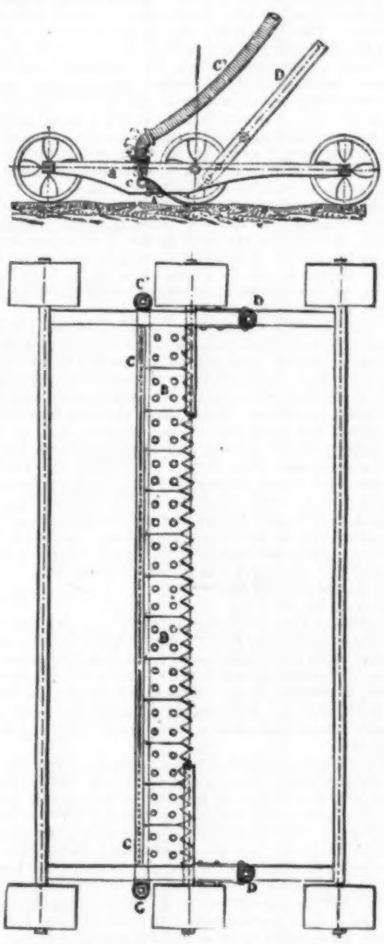


FIG. 2.—Elevation and plan.

MEINESZ'S COMPRESSED AIR DREDGE.

DRAINAGE OF LARGE MARSHES.*

By C. E. HOLLISTER, of Laingsburg, Mich.

MARSHES are not alike in all features, nor in the ease and manner of their drainage. Those lying nearly level with the great lakes would probably have to be diked and pumped out. But land in Michigan is as yet too cheap to warrant resorting to such an expensive process, and we will therefore omit all this class of swamps, and leave them to the engineer of the future.

The northern part of this peninsula was probably once an island, separated from the main land by a broad strait, extending from Saginaw Bay westerly through the region now known as the Saginaw and Grand River valleys. This portion of Michigan is still low, and the country between the Saginaw and Grand Rivers, in Gratiot County, is perhaps the lowest point in the watershed dividing the eastern and western slopes of the State. As this region is some 80 or 90 miles from either Lake Huron or Michigan, the water courses have little slope, actually showing at some portions of their course, at a moderate stage, no fall in the surface of the water for one or several consecutive miles, and at other times having for 10, 15, or 29 miles no more than 10 to 14 inches fall per mile. Their channels are very tortuous, with many a needless mile through marshes and swamps.

Either the river channel must be deepened or the banks leveed and the marshes drained by pumping. Fortunately the former is much the cheaper in first cost, to say nothing of maintenance.

The problem in such cases is not so much what to do or how to do it, as it is to raise the necessary funds for the work. The present owners are not rich; had they been, they would have bought upland; they have no idea that the land will be worth anything if drained, and the work requires a large expenditure all along the line, to which they will never agree except in the case of small streams of say 20 feet in width. The larger streams require some other than the common proceedings under the drain loan.

It needs no argument nor any unusual experience to set forth the unhealthfulness of this state of repeated overflow and evaporation under the summer sun. But it seems that argument and facts and long continued agitation may be necessary to convince the people of the State that they can afford to deepen these river channels, and that a just consideration for the health and lives of those living near such streams will warrant the expenditure and demands the assistance of the State in aiding and urging on this work.

In two noteworthy instances, the deepening and straightening of small streams preparatory to draining the large areas of wet land along their courses have been begun and carried nearly to completion in Clinton County, under the drain law, J. N. Smith, as County Drain Commissioner, planning and directing the work. The South Maple, or south branch of the Maple, has its source in a pond on sec. 16, T. 6, N. R. 1 W.; finds its way without much channel in a southerly direction through wide marshes for about 2 miles, then makes a sweep east and then northerly to the Maple River on section 4 of T. 7, N. R. 1 W. At the point where it turns east it is about 1 mile from the Looking-glass River, which at that point flows west in wide marshes.

Marsh land extends continuously from the creek to the river and drains into both. It is a noteworthy fact that if the creek is cut to the depth of 5 feet from the surface of the marsh and a branch extended to the Looking-glass River, it will bring water from the channel of the latter river through the creek into Maple River. The creek drains about one-third of the town of Victor, and about half of Ovid Township. In some places it flows through a narrow bottom or swale only a few rods wide, but most of the way through marshes or elm swamps ⅛ to ½ mile wide, the main line being about 17 miles long, and having two branches one about 4, the other about 2 miles long, laid out and dug at the same time.

From the mouth of the creek for a distance of 5 miles the bottom as dug is to be 12 feet wide, and is to be deepened gradually as the valley widens until a depth of 5 feet from the surface is attained. At this point the drainage of about a square mile of marsh and the adjacent highlands enters the creek. Above this place the bottom is narrowed to 8 feet. About four miles up the stream is another branch of some miles in length. Here again the width at the bottom is contracted to 4 feet. At a point about 4 miles further up stream another branch comes in and the width beyond is again reduced to 2 feet on the bottom. The whole elevation from Maple River to Cedar Lake is about 95 feet.

It was proposed to make the bottom of drain 4 feet below the surface of the water at the stage when the preliminary survey was made, but the square mile of marsh that drains into it lies so flat that it was necessary to increase the depth to 5 feet. The work was put under contract in August, 1882, and most of the work was done by Jan. 1, 1883. The people along the line were amazed at the idea of going so deep, and thought it unnecessary; now they wish the ditch were deeper.

The cost was $13,000, and the number of acres of wet land which is assessed for benefit is about 3,300, making the cost about $4 per acre were it all to come from this land. About $3,000, however, were assessed to the two towns through which it ran, for benefits to health and highway benefits.

The very remarkable fall in this stream comes from its running north and toward the low part of the State mentioned before. The Cedar River empties into the Grand at Lansing, the Looking-glass at Portland, and the Maple at Lyons. All rise near together and flow nearly west. If then we cross a little west of the meridian, we find the Cedar about 25 feet higher than the Looking-glass, and the Maple about 120 feet below the Looking-glass.

We find still another class of marshes, such as the Chandler Marsh—large, flat; no creek flowing through them, but usually a creek leading from or heading in them. Usually the outlet is level for a long distance, so that we have a flat perhaps 4 or 5 miles long, sometimes double that, and we find that a large expense must be incurred in opening an outlet before we can begin to drain the marsh. When the water is drawn out, such marsh will settle from 1 to 2 feet. The Chandler Marsh has settled so that large stones project a foot, where in a natural state all was water and soft mud, and no one thought of finding a stone within half a mile. The farther down the stream from the marsh, the shallower is the muck, the firmer the ground, and the less it will settle.

In making our calculations, we must, to save expense, go no farther down the stream than necessary; we must lay the grade as flat as will work well, and go no deeper than necessary. Conditions have operated so powerfully upon parties in charge of such works, in all the cases which have come to my knowledge, as to overshadow other less obvious but equally important matters, and have spoiled the job, making it necessary to go all over the same work time and again. Yet if we know and state just what is necessary, we often cannot get our plans adopted, because they look too large.

1. We must allow for the settlement of such marshes and the derangement of our grade. Hence we must cut deeper below and go farther down stream than at first seems necessary. *All fail here*

2. We must go deep enough to allow the marsh to settle and still be able to drain the further edges of the marsh to a depth of 3 feet with a proper grade to the outlet.

3. The outlet must be large enough to carry the water off freely. We must look up the local watersheds and see how much water we have to provide an outlet for.

The Perrin Marsh, in the town of Greenback, Clinton County, is a case in point. For some years they raised quite good crops on the marsh, until the neighbors saw that marshes could be made productive, and had ditches dug running back 1 or 2 miles on each side, but especially on the south. As this is south of the low part of the peninsula, the surface slopes rapidly to the north. These side ditches have a great fall, and flood the marsh by bringing the water in too fast for outlet to carry it off. It also was not dug far enough down the stream. South of St. John's is a similar case which fails for both these reasons, so that the man who was really the pioneer in reclaiming the marsh is completely drowned out and has lost his entire crop for two years on land where before that time he had raised most spring crops, hay, and onions.

The Chandler Marsh also has no outlet. The main ditch stands full of water, as any of you who cross it on the J. L. & S. R.R. may see. Of course nothing can be done with land when the water stands in the ditches at a level with the surface.

The water which falls on a marsh is not that which makes

* A paper read before the Michigan Association of Surveyors and Engineers, January, 1884.—*American Engineer.*

the greatest trouble in draining them. It is that which flows on from the surrounding and higher lands and also that which passes through the soil from the uplands, whether it comes in the form of springs, or by an almost imperceptible soaking through the soil. If we run a branch on each side of the large marshes, we shall cut off all this water which comes from the sides. Otherwise it will flow over the surface and keep the whole marsh wet. This water may be drawn in by laterals, and in small marshes, with but narrow watershed on the sides; this is the river course, but where a wide marsh is surrounded by a wide strip of flat land, we shall succeed better if we run near the edges of the marsh and drain from each side of each ditch with laterals.

Some will object to this view, and say that the middle of the marsh will settle most and hence be too low to drain into the side ditches. In fact, however, the middle of a marsh is generally the highest and can settle most and yet not be too low; but the main reason after all is, there must be a drain along each edge to catch the soakage, or we shall not have it drained; and the cost will be less than to first make a main through the middle, and then laterals and shore drains. If the marsh is wide, the length of the laterals to bring in the shore water, especially if branch drains are needed as often as one in 40 rods, will be greater than the excess of the shore lines over a main in the center.

DISCUSSION.

Mr. J. J. Watkins did not believe that the bottom of a ditch settles; can see no reason for it, and his experience has proved that the top settles and the bottom rises, so that the ditch gets shallower for two causes. Use an 8 rod tape and give distances in rods and links; commissioners liked it better.

Mr. S. N. Beden was certain Mr. Hollister was correct; had tested the bottom many times by reference to a fixed fencework; in one case, when the levels had first been run by another party and ditch constructed from these levels, he had occasion to run the levels again and found a perfect agreement with the first levels on hard land, but on the marsh the result showed either an error of the first party, or that the ditch had settled 12 or 14 inches; believed that the bottom of the ditch had settled; put grade stakes down to grade; there can be no mistake, and they remain in the ditch to show the position of the bottom for all time; get them down by driving with a sledge on a turned and graduated hickory stick, with ferrule to prevent splitting; no difficulty in getting them down 4 or 5 feet; consider a grade of 1·6 feet per mile as small as should be used; object to less than 0·06 foot per 100 feet.

Mr. W. B. Sears thought a better plan was to leave the top of each grade stake 3 or 4 feet above the grade line.

Mr. M. W. Bullock would like to know of a small dredge for such work; has had much difficulty with a floating bog; finally conquered it by constructing a flume in sections and sinking each one to place; prefer to drain small marshes by a center ditch.

Mr. B. T. Wells said that underneath the city of Marshall was a layer of sandstone so porous and dry that it would serve as an outlet to marshes if connected. In one case 10 drive wells in an area of 10 acres removed 10 inches of water in two days.

Mr. Hodgman—In some cases drive wells let water up instead of down; it depends entirely on the underlying strata. Many are dissatisfied with drainage because it is only half done; drainage might as well not be commenced as to be only half completed; had seen drains with a large volume of water work well on a level; get all the fall possible; thought that in marshes underlaid with clay the bottom would rise, and in deep muck marshes it would settle.

Mr. W. Appleton thought that the well method of drainage would always work if the well was made deep enough; had tried it with good success himself, and the well worked well for four or five years; he filled the well with small stone, but in time the silt from the marsh washed among them and ruined the well by filling the pores.

Professor J. B. Davis suggested that the well be made large, and that it be made deep enough so that it should extend some distance into the water-taking strata so as to get a side outlet; a settling well or basin should first receive the water and discharge from its upper surface into the drainage well.

Mr. T. W. Pettee generally set stakes once in 20 rods; some commissioners prefer a grade table to a profile; must one be made? (The law requires one.)

Mr. C. E. Hollister believes in putting the drains on the edge of the marshes and not through the center; the water that does the injury comes almost invariably from the uplands; would have them far enough from the edge of the marsh to allow the velocity of the water from the banks to be checked sufficiently to deposit debris before reaching the ditch. Clinton County has spent about $60,000 on county ditches the past year, but the principal construction has been done by hand. The cost for a ditch with an average depth of 5 feet, bottom width 8 feet, top width 24 feet, has been $5 per rod. The best results were obtained when each man could be induced to take the contract on his own land; had much difficulty with floating bogs. It is impossible to dig them out, when soaked with water; have had good success in freezing weather, by digging but little faster than the muck would freeze; the least grade depends on volume of water; for ordinary ditches should be 1 foot per mile.

THE COST OF STEAM POWER.*

By Charles E. Emery, Ph.D., M.Am.Soc.C.E.

It is believed that civil engineers require at times general information as to the cost of steam power, which is not readily accessible to those who have not made the subject a special study. This consideration has led the writer to present to the Society, with explanations, the accompanying tabular statement, marked "Schedule A," the greater portion of which was prepared within two years for use in a suit in which two of the referees were Messrs. James B. Francis and E. D. Leavitt, members of the Society, respecting the loss of power to a series of mills due to the use of a portion of the water for city purposes. Certain features of the table will be better understood by the explanation that it was claimed by the owners of the water privilege that damages should be based on the cost of purchasing, operating, and maintaining, at each mill, a small engine and a complete independent steam plant, which would at all times just make up the deficiency; while we who represented the city urged that the engines already in the mills should be worked a trifle harder, and that the damages would be represented by a capitalization of the cost of the extra fuel and of a portion of the cost of operation, repairs, and renewals, though provision was made for including a portion of the original cost of machinery.

The use of water commenced on the first day of January, 1874, so the costs are all referred to that date. Some of the features of the table are revised, according to the experience of the writer, from a number of elaborate tables presented for the mill owners on the trial by Mr. J. C. Hoadley, M.E. The cost of the machinery given by him corresponded very closely with ruling prices collected for the Novelty Iron Works, New York, in the years 1873–4, and were adopted, except that the prices of the small engines were increased slightly to allow for the application of a fixed cut-off, which was proper if the theory of the mill owners prevailed that a small fixed quantity of power was to be restored at each fall corresponding to the power available with the water condemned. This provision affects the comparison with the ordinary commercial cost of power in small engines in manner hereinafter indicated.

The table shows the various items of the cost of a steam power per horse power per year, and also the present value of steam power maintained for ever, when produced in small or large quantities. Some presentations, made in particular form to meet the issues in the particular case, have been retained as being of interest.

It will only be attempted at this time to fix upon the minds of those present the governing influences which affect the cost of steam power, referring to the headings which show clearly the several items upon which the final determinations are based.

As a general result it will be observed that steam power costs proportionately very much more in small than in large quantities. The great difference shown in the table is largely due to the fact that the whole time of an engineer is charged to the cost of the power both for the small and the large engines. In some kinds of business the engineer can properly have other duties, which should be considered. Independent of this, however, small engines and boilers are much less economical than larger ones, so that the cost of fuel is much larger even at a fixed price per ton, as per comparison in table, whereas commercially the price of the fuel in small quantities is also greater, and would further increase the proportionate cost. All other items of cost are also proportionally greater for small powers. Referring to the table, the engines are rated by the dynamometric power, col. 1, or the power each will deliver independent of its own friction, shown in col. 7; which latter varies from 20 to 9½ per cent. of the indicated power, or that developed in the cylinder, shown in col. 8.

The costs in feed water evaporated into steam, per indicated horse power per hour, col. 9, and the weights of water evaporated per pound of coal, col. 10, are mostly based on experiments made from time to time by the writer with engines and boilers of various sizes, and correspond well with experiments made by others. From these the coal per indicated horse power per hour, col. 11, is obtained, and, as will be seen, varies from 5·6 pounds to 2·52 pounds according to the size of the engine. The results shown for the smaller engines are even better than will, on the average, be obtained commercially, as they apply to the particular case of an engine of proper size developing a fixed power and operating expansively, as previously explained. In ordinary practice these engines are generally too large for the work, and can rarely be operated expansively, under which circumstances the amount of coal used for the first five sizes should be increased 25 per cent.

The cost in fuel, per horse power given for the 50 horse power non-condensing engine can readily be obtained continuously with good engines of from 50 to 100 horse power, and are, therefore, correct for the particular conditions, but in average practice these engines are often too large for their work, and an addition of 10 to 15 per cent. to the costs given would more nearly represent ordinary commercial results.

The costs given for condensing engines are readily obtainable, but the writer once tested a pair of 100 horse power engines which required 30 pounds of feed water per horse power per hour. The steam was wet and the governor not in good order, which explains the low duty, but illustrates that high ones are not always obtained in practice. The table shows correctly, however, the cost of fuel per horse power in large Eastern mills with double condensing engines of 150 to 300 horse power each, the costs being derived from the actual coal consumed and power developed for a series of years, as testified to in court by several different parties from different mills.

It may be added that still better results have been obtained with compound engines, particularly marine and pumping engines, but for mill purposes the designs have too often been undertaken by incompetent persons, who, it is true, caused the steam to exhaust from one cylinder to another, but neglected details necessary to success, and so obtained no better results than those given with the better class of single engines.

Col. 13 makes provision for insurance on the plant at the low rate attainable by the mutual plan, and col. 14 provides for taxation at the rate named in the heading.

In columns 15 and 17 an attempt is made to graduate the pay of the engineer and provide for the number of firemen necessary for engines of the different powers mentioned, the engineer acting as his own fireman for the smaller powers. One fireman is considered sufficient up to 300 horse power; for 400 horse power provision is made for a boy to assist the fireman, and for 500 horse power pay for two firemen is provided. These provisions cannot be considered exact for all conditions, but approximately show the law of decrease of cost of labor as the power is increased.

The cost of supplies, viz., oil, waste, packing, etc., col. 19, was derived from the reports of several steam mills. These items I find less, as they should be, than those reported for short stroke marine engines. In col. 21 the writer has adopted the estimate of the mill owners as to the cost of the usual repairs.

In col. 23 the operating expenses mentioned, with the exception of the coal, are summed, and amount, as shown in col. 24, to $131.13 per horse power per year for the 5 horse power engine, and $7.64 per horse power per year for the 500 horse power engine.

In col. 25 are shown the costs of the coal on the basis of $4.17 per ton, including cartage, which was the price established as an average for a number of years at a particular location near the seaboard, and can readily be corrected for average prices at any other location. The cost of fuel, per table, varies from $45.33 per horse power per year for the 5 horse power engine to $18.02 for the 500 horse power engine. This item for the smaller engines would in most cases need to be increased, for reasons previously mentioned.

The several items are summed in cols. 27 and 28, and from the latter it will be seen that the total cost of a horse power for one year is $176.46 for the 5 horse power engine, and $25.66 for the 500 horse power engine.

An item for interest properly belongs in the current expenses, but has been omitted in this branch of the subject, as it is complicated with the question of renewals. In most cases it will be proper to charge simple interest on the cost of the plant, in addition to a yearly annuity which, if invested, will produce an amount sufficient for renewal in a definite period of years.

In the other branch of the subject, for the purpose of estimating the present value of a horse power maintained continuously, complete renewals are assumed te be necessary every 30 years, when, as shown in col. 5, the present value of the cost of renewals on a 6 per cent. basis becomes 21·08 per cent. of the original cost, and this summed with the original cost, and the capitalization (assumed also at 6 per cent.) of operating expenses and of cost of coal, cols. 29 and 30, gives the totals in col. 31, from which are derived the present values of the total cost of a horse power maintained forever, when the same is generated in small and in large quanties.

The result shows that steam power in sufficient quantity may be maintained forever by an outly of $660 per horse power, a portion of which would be expended for plant, and the balance invested to provide for operating expenses and renewals.

It thus appears that for ruling prices given, water power cannot compete with steam power when the present value of all proposed improvements, together with the capitalization of the cost of repairs and renewals, exceeds $660 per horse power. Even then the water power should be continuous the year round, or a duplicate plant may be necessary, and the justifiable amount for permanent improvements to secure water power be greatly diminished.

In this connection, a brief extract from a memorandum of the writer on the subject will probably be of interest.

The value of a waterfall in a given location for power purposes depends upon a variety of conditions, such as the cost of permanent plant to make the power available, the quantity of power that can be obtained compared with the work to be done, and, in a very important, if not the most important, degree, upon the reliability of the power throughout the entire year and continuously for a series of years.

For a country saw-mill operated by men having other duties at times, a simple torrent, dry or nearly so at times during the summer, will answer very well. The farmers' boys can get in their harvests in the dry season, get out and haul logs before the snow melts, and saw them by the water power when the stream is full. Everything is of the simplest description; no labor is left idle, and the cost of the whole plant is so small that the mill may be unused for long periods without loss worthy of consideration.

Such a state of things is not possible with the manufacturing interests of modern times. Large contracts are to be filled; large numbers of operatives are employed, skilled only in particular branches of the particular work done; hundreds of thousands of dollars of capital are invested—the mills cannot be stopped if the owners hope to compete with others doing business in a business way. If the water power fails for a season, steam is employed, and indeed, from its greater reliability, steam is used exclusively in many cases in successful competition with water power. Even the country saw-mills are giving way in many localities to a steam mill in the woods close to the logs, using the slabs for fuel, and teaming out only finished lumber.

The value of a water power is then most readily measured by the cost of the same amount of steam power. The comparison naturally resolves itself into a progressive series from full water power to full steam power, which may be briefly stated as follows:

I. Water power is most valuable when there is an ample supply at all times; that is, when water is abundant and cheap. Even if there be a small diminution for a small portion of the year, a part of the machinery and capital must be idle, and the output and profits of the establishment be proportionately reduced.

II. Water power ceases to be of considerable value when the variations in the power available form a considerable proportion of the total power required. Manufacturers in such locations, in order to furnish products to compete with others, are forced to use, in addition to the water, steam power amply sufficient to supply all deficiencies. When the variations are large, the steam power becomes the main stay, and the water is used simply to save fuel. The water power is less valuable than in previous cases, because the plant for two different systems must be constructed and maintained.

III. The only remaining step is to discard the water power altogether. When such power is very unreliable, the interest on the plant and cost of maintenance will equal, or nearly equal, the cost of the fuel necessary to produce the same power, and the reliability of the steam makes it the more desirable, and it becomes the sole dependence.

Again, in cotton and woolen mills steam is required for other purposes than power, such as heating the mills, drying the yarn, boiling starch, dyeing, etc., which makes some steam plant necessary in any case; and as in most locations all these operations can be performed by exhaust steam, all the power obtained from the steam which is used the second time practically costs nothing compared with water power, which reduces the relative value of water power, even under the most favorable conditions referred to in Division I, above.

Of course, in all cases the original cost of plant and expenses of maintaining the same must be considered with relation to the water power as well as the steam; and when steam is used in connection with water power, the latter must be charged as much as ever with the cost of the dams, head and flood gates, races, flumes, water-wheels, etc., and the danger from floods and cost of repairs and renewals will not be lessened in the slightest degree.

DISCUSSION.

James B. Francis, M. Am. Soc. C. E.—In the paper read by Mr. Emery, reference is made to a hearing before referees for the settlement of damages for the diversion of water from certain factories in which it had been used as motive power. I happened to be one of the referees in that case, and the paper is substantially the same as one submitted by him, as an expert, at that hearing. The question in reference to which it was then submitted was the cost of supplying, perpetually, an amount of steam power equivalent to that given by the water diverted. One important element in the cost is the periodical renewal of the plant, the allowance to be made for which depends on the length of time assumed for the successive renewals. In the question before the referees the time should be that in which the plant from ordinary wear would become unprofitable to use; renewals usually

* Read at the Annual Convention, St. Paul, Minn., June 19, 1883.

ESTIMATES OF COST OF STEAM ENGINES AND BOILERS COMPLETE, AND OF THE COST OF OPERATING THE SAME FOR 309 DAYS IN THE YEAR, INCLUDING REPAIRS AND RENEWALS, ON THE BASIS OF PRICES FOR ENGINES AND BOILERS RULING IN JANUARY, 1874, AND COAL AT $4.17 PER TON, DELIVERED ON THE PREMISES.

By CHARLES E. EMERY, Ph.D

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33
Power of Engine.		Estimated Original Costs.				Data for Calculating Operating Expenses.						Operating and other Current Expenses.																Capitalization at 6 pr. ct.				
Dynamometric Horse Power.	Kind of Engine.	Cost of Engine and Boiler and all appurtenances, set up in Massachusetts, on the first day of January, 1874, including foundations, boiler settings, pipes, gauges, tools, etc., not including Engine and Boiler House and Chimney	Cost of Engine and Boiler House and Chimney.	Present value of the Cost of Renewing the Engine, Boiler and all appurtenances every thirty years. 21.0637 per ct. of col. 3.	Total, including Cost of Engine and Boiler and investment for renewal, excluding Buildings and Chimneys. Sum of cols. 3 and 5.	Percentage of Friction of Engine.	Indicated Horse Power.	Feed Water per indicated Horse Power per hour	Feed Water evaporated in Boilers per pound of Coal.	Coal per indicated Horse Power per hour.	Total Coal per day of 10 hours, with 1-8 added for starting and banking fires.	Insurance.—Yearly cost at the rate of 1-2 of 1 per cent. on total valuation in col. 3.	Taxation.—Yearly cost at the rate of $15 per M. on 75 per cent. of total amount in col. 3.	Engineer. Per day.	Engineer. Per year of 309 days.	Fireman. Per day	Fireman. Per year of 309 days.	Supplies, Oil, Waste, Packing, &c. Per day.	Supplies, Oil, Waste, Packing, &c. Per year of 309 days.	Repairs—ordinary and extraordinary—including grates and flues. Per day.	Repairs—ordinary and extraordinary—including grates and flues. Per year of 309 days.	Total cost of operating and other current expenses, except coal. Per year. Sum of cols. 13, 14, 16, 18, 20 and 22.	Total cost of operating and other current expenses, except coal. Per Horse Power per year.	Cost of Anthracite Coal at $4.17 per ton, including 25 cents per ton for carting. Per year of 309 days.	Cost of Anthracite Coal at $4.17 per ton, including 25 cents per ton for carting. Per Horse Power per year.	Total cost of operating and other current expenses, including coal. Per year of 309 days. Sum of cols. 23 and 25.	Total cost of operating and other current expenses, including coal. Per Horse Power per year. Sum of cols. 24 and 26.	Of Costs, as per col. 23, of operating and other current expenses, except coal.	Of Cost of Coal.	Sum of original and capitalization of operating and other expenses, including investment for renewal. Sum of cols. 6, 29 and 30.	Present Value of Total Cost per Horse Power maintained continuously, including proportion of original cost of plant, renewals, &c. Excluding Buildings and Chimneys.	Present Value of Total Cost per Horse Power maintained continuously, including proportion of original cost of plant, renewals, &c. Including Buildings and Chimneys.
H. P.		Dollars.	Dollars.	Dollars.	Dollars.	Per ct.	I. H. P.	Pounds.	Pounds.	Pounds.	Pounds.	Dollars.	Dollars.	Dollars.	Dollars.	Dollars.	Dollars.	Dollars.	Dollars.	Dollars.	Dollars.	Dollars.	Dollars.	Dollars.	Dollars.	Dollars.	Dollars.	Dollars.	Dollars.	Dollars.	Dollars.	Dollars.
5	Portable Upright,	645	313	135.98	781	20	6.25	42	7.5	5.60	994	9 23	7.68	1.75	540.75			.20	61.80	.13	40.17	655.63	131.13	226.64	45.33	882.27	176.46	10 927.17	3 777.33	15 485	3 097	3 152
10	" "	988	408	208.28	1 196	20	12.50	38	7.5	5.10	717	4.94	14.82	1.75	540.75			.25	77.25	.16	49.44	687.20	68.72	412.44	41.24	1 099.64	109.96	11 453.67	6 874.00	19 534	1 902	1 907
15	" "	1 487	504	313.48	1 800	18	18.29	36	7.5	4.80	988	7.44	22.31	2.00	618.00			.27	83.43	.17	52.53	783.71	52.25	568.33	37.89	1 352.04	90.14	13 061.83	9 472.17	24 334	1 623	[illegible]
20	" Horizontal.	1 981	589	417.62	2 399	15	23.53	34	8	4.25	1 125	9.91	29.72	2.00	618.00			.30	92.70	.22	67.98	818.31	40.92	647.14	32.36	1 465.45	73.28	13 636.50	10 785.67	26 823	1 341	1 361
25	" "	2 441	699	514.60	2 955	14	29.07	32	8	4.00	1 308	12.21	36.62	2.25	695.25			.33	101.97	.27	83.43	929.48	37.18	752.41	30.10	1 681.89	67.28	15 491.33	12 540.17	30 987	1 240	1 269
50	Stationary, Non-Condensing.	5 331	1 029	1 122.55	6 453	12	56.52	27	8.25	3.27	2 091	26.66	79.97	2.00	618.00	1.40	432.60	.36	111.24	.44	135.96	1 404.43	28.09	1 202.82	24.06	2 607.25	52.15	23 407.17	20 047.00	49 909	998	1 318
100	Condensing Single,	9 207	1 487	1 940.96	11 148	11	112.36	23	8.8	2.81	3 300	46.04	138.11	2.25	695.25	1.50	463.50	.40	123.60	.77	237.93	1 704.43	17.04	1 898.28	18.98	3 602.71	36.02	26 407.17	31 638.00	71 193	712	[illegible]
150	" "	13 046	2 129	2 750.28	15 796	10	166.67	22.2	8.8	2.52	4 725	65.23	195.69	2.50	772.50	1.50	463.50	.47	145.23	1.00	309.00	1 951.15	13.01	2 718.00	18.12	4 669.15	31.12	32 519.17	45 300.00	93 615	624	[illegible]
200	" "	16 785	2 745	3 538.51	20 324	9.5	220.99	22.2	8.8	2.52	6 265	83.93	251.78	2.50	772.50	1.50	463.50	.55	169.95	1.24	383.16	2 124.82	10.62	3 603.86	18.02	5 728.68	28.64	35 413.67	60 064.33	115 802	[illegible]	716
250	" "	20 426	3 304	4 306.09	24 732	9.5	276.24	22.2	8.8	2.52	7 831	102.13	306.39	2.75	849.75	1.50	463.50	.65	200.85	1.47	454.23	2 376.85	9.50	4 504.68	18.02	6 881.53	27.52	39 614.17	75 078.00	139 424	[illegible]	[illegible]
300	" "	23 809	3 841	5 038.24	28 937	9.5	331.49	22.2	8.8	2.52	9 398	119.50	358.49	3.00	927.00	1.50	463.50	.80	247.20	1.70	525.30	2 640.99	8.80	5 406.08	18.02	8 047.07	26.82	44 016.50	90 101.33	163 [illegible]	544	572
400	" "	29 958	5 722	6 315.57	36 274	9.5	441.99	22.2	8.8	2.52	12 530	149.79	449.37	3.00	927.00	2.25	695.25	.95	293.55	2.20	679.80	3 194.76	7.99	7 207.72	18.02	10 402.48	26.01	53 246.00	120 128.67	202 [illegible]	524	567
500	" "	36 220	7 260	7 635.88	43 856	9.5	552.49	22.2	8.8	2.52	15 663	181.10	543.30	3.00	927.00	3.00	927.00	1.15	355.35	2.87	886.83	3 820.58	7.64	9 009.94	18.02	12 830.52	25.66	63 676.33	150 165.67	257 [illegible]	515	500

are made from other causes, notably from a greater power being wanted or from the desire to adopt modern improvements, resulting in greater economy, neither of which could be properly considered in this case. In Mr. Emery's paper thirty years is assumed, but the data for it appear to be very vague, and it was one of the most troublesome questions on which the referees had to pass. If any of the members can throw any light upon it, I, for one, should be much pleased to hear from them.

E. D. Meier, M. Am. Soc. C. E.—The schedule states the charge for firemen for running a 400 horse power engine to be $2.25 per day, and for running a 500 horse power engine, $3 per day.

I am inclined to think that on the larger engines, say from 250 horse power up, the price given in this schedule for a fireman is too low. I should say that for a 400 horse power engine, even at the low rate at which this table is figured, about 2·8 pounds of coal per horse power per hour (which, I suppose, is only possible for anthracite coal, and must be so intended), the 400 horse power would require two firemen and the 500 horse power engine about three, and good men at that, worth not less than $1.50 per day each.

Mr. J. F. Holloway—Availing myself of the kind invitation extended by the society, I would say that the history of the steam engine in this country does not cover a very great length of time; and we all know that within the past thirty years there have been great changes both in regard to the generation as well as the use of steam; and it would seem from our short experience in the past quite impossible for any one to predict what may be the changes and improvements in the next thirty years. During the five, ten, or fifteen years past, very many radical changes have taken place in the construction of boilers, valves, governors, and all the various appliances pertaining to the steam engine, and it would be a rash undertaking for any one to prophesy what the next thirty years may do for it; that being so, I cannot see how one can safely predict what the cost of renewals may be.

It may be, and, indeed, it is quite probable, that very many persons now using engines will find, within the next ten or fifteen years, sufficient reason to warrant them in changing their entire plant.

I think that we have not as yet had a sufficient length of time to establish data by which to estimate with accuracy the time in which renewals must of necessity be made.

Chas. E. Emery, M. Am. Soc. C. E.—If there be no further questions, I will say, first, in regard to the time that should be reckoned for complete renewal, that there is a fairly good allowance made for repairs, which will cover, not entire renewals, but certainly keep the boilers in good condition, and meet the cost of new packing, repairing valves, etc. There are plenty of engines in the country thirty years old, and running apparently as well as when new. There are not so many boilers, but yet the boilers in many cases last as long as that. In this particular case the expert on the other side had made his estimate for renewal every thirty years, and this not being questioned by the mill owners could not well be by the city. It is fair to say, though, and the referees discerned it, too, that this time is probably longer than it should be for an average. I think it would be more fair for ordinary practice to take about twenty. The engines last much longer than that on the average, for if one be removed on account of improvements, increase of plant, etc., it generally goes into some other place and is used over again, and may have a run in all of forty years or more. The boilers, however, do not, on the average, last more than twenty years, and when of a peculiar kind may be removed much sooner. The ordinary tubular boiler remains in use sometimes for thirty years, and many boilers are now in good condition which are over twenty years old.

More frequent renewals would simply affect the calculations given in col. 5 of table, and correspondingly change the final summations. For renewal, every thirty years, the present value is a little over 21 per cent. of the original cost. This would be increased to 45·31 per cent. for renewal every twenty years.*

In discussing the matter with one of the referees after the award I found that they had used a short period for renewal, on account of the circumstances at that particular locality. The mill owners were overworking the engines, breakdowns were frequent, and renewals required every few years. Such conditions would not apply where parties started out in business to construct a cotton mill with a certain number of spindles, or a flouring mill with a given number of run or stone, and put in the power to correspond.

Referring to Mr. Holloway's remarks as to the impossibility of calculating the improvements in steam engines, I have thought of the subject a great deal, but I am not aware of very many improvements in the steam engine for the last twenty or thirty years. They are changing its form, they are putting in novelties in detail, but the results that we obtain are the same, pretty nearly, as those from the original Corliss engine. The trouble is that very much which is called improvement of the steam engine is merely a change of shape; it is like getting the gas into a building by starting at one side and branching toward the other, or by running around in another direction. It is very unfortunate to have to say so, but the greater part of the duties of the engineer of the present day, particularly in regard to steam machinery, is to throw out as worthless or unnecessary most of the novelties, and retain most of the old devices, rather than to take up something grand and new—some improvement which will make a very great advance and a very important change in the amount of fuel consumed per horse power.

The calculations are based upon $1.50 per day for each fireman. This would be $3.00 per day for firemen for a 500 horse power engine, as it generally would be too much work for one fireman. For the 400 horse power engine, allowance was made for a boy to assist one fireman. It is very difficult to make perfect gradations in an estimate of this kind. When there is a little more work than can be attended to by one or two men, it is customary to put in helpers at cheaper rates.

I think I have answered the questions so far as presented.

J. P. Frizell, M. Am. Soc. C. E.—What was the estimate of the length of time per day these engines were to be run?

Mr. Emery—That is mentioned in one of the headings; see col. 12. "Total coal per day of ten hours, with one-eighth added for starting and banking fires."

Mr. Frizell—It is customary in this country for flouring mills to run night and day.

Mr. Emery—That would take off the one-eighth, but it

* If x = present value in relation to principal and n = no. years, for compounding yearly at 6 per cent.:

$$x\,(1{\cdot}06)^n = 1 + x$$

$$x = \frac{1}{(1{\cdot}06)^n - 1}$$

might introduce another element, for the machinery could not be kept in quite as good order when they run so many hours in the week.

The custom in the flouring mills in the East is to run from about 4 o'clock Monday morning to about 8 o'clock Saturday evening. This gives a little opportunity for repairs at night, and they sometimes make Saturday night very long indeed.

Mr. Frizell—The only time they get to make repairs here is on Sunday.

Mr. Emery—I suppose the same thing is done elsewhere. It is not always mentioned in that way, though.

Mr. Holloway—I might add, by way of explanation, that while I would very likely agree with Mr. Emery in regard to what have been the real improvements in steam engineering in the past thirty years, still, when I speak of renewals, I include those instances in which a glibly talking agent comes to a proprietor with a new style of engine, or some new device for generating steam, and by the magic of his eloquence induces him to change his engine on account of some supposed improvement, although, as suggested, the improvement may be like that of bringing gas into a house from some other direction. I claim that if the proprietor does make the change in his engine, or in parts of it, it is really a renewal just as much as if he had worn out his old engine, even if he does not realize the improvement he was led to expect.—*Trans. Amer. Soc. Civil Engineers.*

THE HULL AND BARNSLEY RAILWAY SWING BRIDGE.

REFERRING now to the engravings which we give of the swing bridge over the Ouse, it will be seen that it has three bowstring spans, namely, two shore spans of 81 feet each, and a center swing span 248 feet in length, giving openings 100 feet clear. The central pier consists of eight outer cast iron cylinders, the upper length being 6 feet in diameter, and one central cylinder as shown, 7 feet 6 inches in diameter, this one carrying the pivot upon which the bridge turns. The ends of the swing span and the river ends of the shore span rest upon girders supported on four cast iron columns 6 feet in diameter. These columns are sunk down to the hard sand, which is almost a sandstone, the position of which is shown by the strata section given in the top engraving. It has come especially within the province of Mr. W. Shelford to consider the design and construction of the bridges on the railway, and after a visit of inspection to large numbers of the railway, bridges of the Continent, paid with a view to test the often asserted superiority in design and economy of French and German bridges over those of England, he came to the conclusion that while there was much to be admired in some of the foreign bridges, there was not a little to be shunned. An endeavor was made in the design of the bridges—the Ouse swing bridge included—to dispose the metal to the best advantage and secure a good appearance. The total quantity of wrought iron in the superstructure is 649 tons. The weight per foot run is 1·58 tons. The character of the bridge will be readily gathered from our engravings. It differs from the Northeastern Company's swing bridge of the same span a few miles up the river, in that it is of the simple lattice instead of the plate girder form, and it certainly has secured the better appearance.

The depth of the main girder at the center is 21 feet. Here it is surmounted by a watch tower to be occupied by a signalman, under whom the whole of the movement of the bridge and the locking of the railway signals will be controlled. The positions of the hydraulic machinery will be readily gathered from Fig. 3, showing the apparatus for turning the bridge, while Fig. 4 shows the cylinder and knuckle gear by which the ends are slightly raised to admit the resting blocks as soon as they are over the outer piers. Before opening the bridge the ends are again raised and the blocks withdrawn from under the ends to leave it free to turn.

The hydraulic pumps and engines by which they are worked are situated in one end of the central pier, by which the swing span is protected when open from injury by vessels not in control. Part of this end of this pier is shown at Fig. 2.

FORGED STEEL WHEELS.

THE breakages of colliery and tramway wheels made of cast metal (iron and steel) having been found to be very great in general, the matter has been taken up by Messrs. John Brown & Co., of the Atlas Steel and Iron works, Sheffield, and they are now largely manufacturing the forged steel wheels illustrated above. These wheels are the invention of Mr. W. Eyre, of the above firm, and, as may be seen from Figs. 2 and 4 of above engravings, the wheels are stamped out of plain disks of plate steel. They can be made either fast or loose on the axle. When the latter, as in Fig. 1, a cast steel bush is placed in the center hole of the wheel, which is riveted to the wheel, and afterward bored out in the lathe. In the case of fast wheels (Fig. 3), the collar of the axle and the wheel are riveted together, and the end of the axle is also riveted over the wheel. The wheels shown at Fig. 2 have outside bearings, while those shown at Fig. 4 have them inside. The advantages claimed for these wheels are

FIG. 1. FIG. 2.

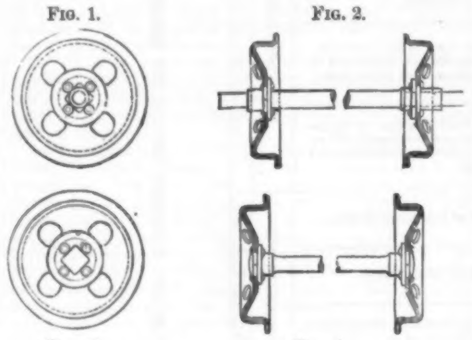


FIG. 3. FIG. 4.

FORGED STEEL WHEELS.

that absolute freedom from breakages is insured, the form of the wheels gives great elasticity combined with strength, and the wheel is lighter than those now in use, an important consideration for colliery proprietors. The wheels have been in use at several South Yorkshire collieries, and the good results obtained have induced the manufacturers to make special arrangements for the production of the wheels on a large scale.—*Iron.*

AMERICAN AND ENGLISH FREIGHT CARS.

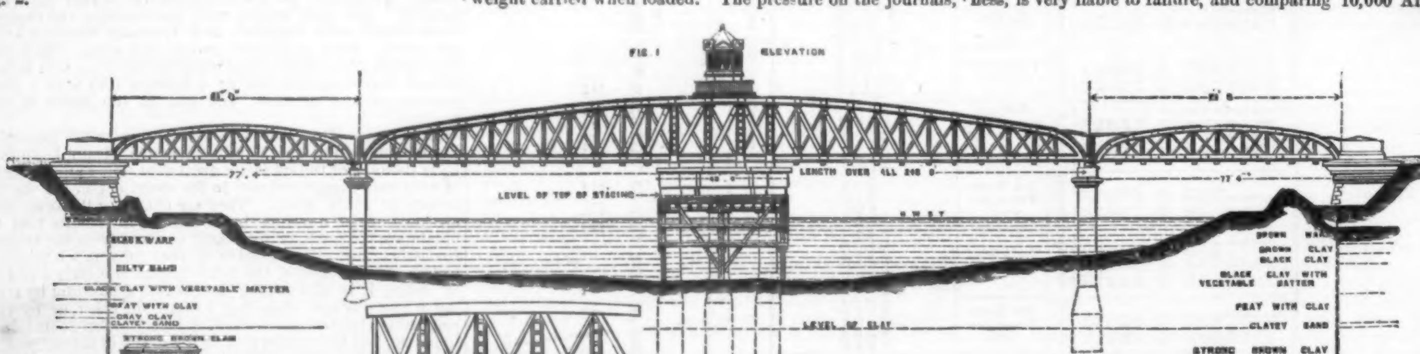
THE small and decreasing cost of transport by freight train in America has lately excited much interest and emulation in this country. The peculiar construction of the freight cars is probably one of the many factors that contribute to make carriage by rail so cheap in a country where wages are high, and steel, iron, and even coal are dearer than in England. Most articles of freight in America are conveyed in box cars, which have rather more than double the cubic capacity of an English covered wagon. The full load, which a few years ago was 20,000 lb., has been increased to 40,000 lb., and even to 50,000 lb.; while the average weight of the car itself has been increased only from 20,500 to 22,000 lb. The average weight actually carried in a loaded car on the Pennsylvania Railroad has increased from 20,260 lb. in 1877 to 24,620 lb. in 1881, though, of course, a large proportion of old and light cars were still running. The following comparative table shows clearly the relative results attained with typical vehicles for the conveyance of merchandise. The average load is in each case the average weight carried, whether loaded or empty, and not, as above, the average weight carried when loaded. The pressure on the journals, etc., therefore, represents the average results under all circumstances:

	English. lb.	American, lb.
Average weight of vehicle	11,000	22,000
Average weight of lading	5,250	16,000
Total average weight	16,250	38,000
Deduct weight of wheels and axle.	3,700	5,800
Load on journals.............. ..	12,550	32,200
Length and diameter of do...	8 in. × 3½ in.	7 in. × 3¾ in.
Area of bearings, number by length by diameter...	112 sq. in.	210 sq. in.
Pressure on bearings per sq. in....	112 lb.	153 lb.

The figures given above are deduced from careful observations on English lines, and reports, etc., of various representative American roads, and may, therefore, be accepted as fairly accurate. They exhibit pretty clearly the main results of the differences in design between English goods trucks and American freight cars. It will be noticed that though the gross weight of the American vehicles is just double that of the English, the average load is three times greater. Excluding the wheels and axles in the American vehicle, the weight of the load almost exactly equals the tare of the vehicle; but in England, the weight of body framing, springs, etc., exceeds the load by 28 per cent. This great difference is probably due to the fact that the materials are so well disposed in an American freight car that great strength is attained with a moderate weight. The sides form a deep truss, the depth being about ⅙ of the span, and the bottom is also strongly trussed, and, owing to the central buffer system, needs little or no diagonal bracing in a horizontal plane. Two English goods trucks have eight buffers and four draw hooks, with their accompanying gear, against two central buffers and four "dead blocks" on an American freight car of greater cubic capacity. The saving in wrought iron hinges, knees, corner plates, etc., is also considerable, while the American freight car bogie, with its spiral springs and axle boxes bolted to the bogie frame, weighs little more than the corresponding axle guards and plate springs of an English wagon. The smaller number of doors, ends, and head stocks also reduces the comparative dead weight of the longer vehicle. The comparison is still more unfavorable if the typical English vehicle be represented by a covered wagon instead of an open truck, protected by a tarpaulin. The dead weight, excluding wheels, is then more than double the average paying load, instead of being equal to it, as in American practice. This great discrepancy is not due to weakness, as an examination of freight cars in traffic and in the repair shop shows that the bodies and frames of American box cars stand shunting and rough usage fully as well as our own. The medium sized open cars, used almost exclusively for coal, are generally sagged in the middle, showing the value of the trussed sides of the covered cars. The depth of truss possible under the floor is in itself insufficient to support a timber framed loaded vehicle, with bogie centers 24 ft. apart.

Referring again to the comparative table, it will be seen that the wheels and axles of the English vehicle are far heavier in proportion to the load they carry, weighing 29 per cent. of the weight on the journals, instead of only 18 per cent. as in the case of the American vehicle. This can only be partly accounted for by some 3 in. or 4 in. difference in the diameter of the wheels and 6 in. to 8 in. difference in the length of the axles, and it is chiefly due to the insufficient strength of the American wheels, as shown by their frequent breakage, to which reference will be made further on. The size of journal given is the largest in general use in America, and was adopted in 1879, after considerable discussion, as the Master Car Builders' Standard. Journals measuring only 5¼ in. by 2⅞ in. are, however, still in frequent use. The pressure per square inch, even on the larger American journals, is much in excess of that obtained in England, and it is not therefore surprising that much trouble is experienced in America from hot boxes.

The chilled wheel, despite the greatest care and watchfulness, is very liable to failure, and comparing 10,000 Ameri-



THE HULL AND BARNSLEY RAILWAY.—SWING BRIDGE OVER THE OUSE.

can wheels with 10,000 English wheels, it is estimated that in a year 170 American wheels will have broken completely or failed in the thread or flange, 210 will be found cracked in the disk or stiffening ribs, and 14 will have cracked in the boss. In a corresponding number of English wheels, it appears from the Board of Trade returns that 6 wheels will be found to have cracked or split tires, while a failure of the ordinary wagon wheel in the boss or spokes is almost unknown.

This disproportion seems enormous, but the figures given are at least approximately correct, and the *Railroad Gazette*, commenting on the statistics on which the above figures are based, estimates that out of the 5,600,000 freight car wheels in America, 28,000 are dangerously broken every year. The wearing qualities of chilled wheels is a somewhat distinct question, which has been much discussed, but still remains in a state of great uncertainty, the estimates of the average life of a chilled wheel varying from 40,000 to 130,000 miles, many wheels giving way by being skidded through the chill. There can, however, be no doubt that our wheels wear longer and far more evenly, and that the 18 to 20 years' life expected of a steel tire under an English goods wagon exceeds anything ever attained by a chilled wheel. This is only partly due to the American wheel being smaller and more heavily laden; for assuming that the wear is directly as the load and inversely as the diameter on tread, an American wheel should run 80 per cent. of the mileage of an English wheel for the same amount of wear.

The heavier loads and the increased use of remelted wheels have intensified the evil, while the growing manufacture of steel tires provides a remedy, and the cheap but untrustworthy chilled wheel seems likely to be superseded by some form of elastic bodied steel tired wheels.—*The Engineer.*

THE CABLE RAILWAYS OF CHICAGO.—SOME OF THE DIFFICULTIES AND OBJECTIONS TO THEIR USE IN CROWDED CITIES.

MR. F. C. CROWLEY, of New York, a gentleman largely identified with the street railway system in several of our principal cities, and who has for thirty years been engaged in the construction of street railways, having recently visited Chicago to inspect the experiment in rope traction for street service now being tried there, we requested our reporter to procure from him replies to such questions as appear to us important in this connection, that we may place before our readers the most complete information concerning the practical working of the system in Chicago, from an unprejudiced source and based upon existing facts. The report is as follows:

Did you examine the so-called cable railway system when recently in Chicago?

I did.

Will you please state some of the results of your investigation?

For ten days I devoted portions of every day to a careful inspection of its method and operation, observing the movement of the engines at the power station, by riding on the cars—generally the grip cars—and walking over the tracks. I saw the general results attained by the system. I made this examination in my own interest, as, having been engaged for many years in the construction of street railways, I wished to learn if it was a practicable method for street service on roads I have in contemplation. I studied the matter as thoroughly as possible, not through the opinion of others, but from my own observation of the actual facts, at all hours of the day, and under all the varying conditions of street traffic.

How is the road constructed?

The first work in the street is to cut a trench four or five feet deep and nearly as wide at top, continuous between tracks through the entire route; this trench is lined with broken stone and cement, and has sewer connections at intervals. In this are placed the yokes, frames, and wheels upon which the ropes are to run. These being in place, the surface is covered with a frame and plating of iron, and on that is laid the street paving, the tracks being laid on wooden stringers in the usual manner, which are supported by cast iron frames or bases, they in turn being supported by the iron yokes which cross the trench every three or four feet, the whole forming an elaborate underground structure of iron. The trench being complete, with its manholes for access at frequent intervals, and the mechanical appliances being in place with the wheels in position, the system is ready for the rope. At the power station are engines, four, I think, of 250 horse power each; by these engines movement is conveyed to a drum or cylinder, 8 to 10 feet in diameter. Around this drum the wire rope is passed, from thence out to the roadway through the continuous trench before referred to, and through the whole extent of the road over one set of wheels, between one pair of tracks or rails. At the other end of the road the rope passes again around another drum or wheel, to the other return pair of tracks, and thence down through the entire length of the trench between those tracks to the power station. The end is there spliced or joined to the end remaining at the drum; when the splice is completed, motion is conveyed to the rope through its entire length, by the revolution of the cylinder. In the State Street line, the length of rope is about seven miles, and so long as the rope holds, the drum revolves and the service on the road is light. The motion of the rope is constant at the speed fixed at the engines.

You have described the construction of the roadway and the movement of the rope. How is movement communicated to the cars?

It is by connecting the cars with the rope by means of a grip, which is a metal bar depending from what is called a grip car, *i. e.*, a small car moving in advance of the passenger car, with the machinery for working the grip. This grip rod passes through an open slotway formed of metal plates or bars, with space between them, which must be open continuously through the entire roadway between each pair or tracks; this slotway in Chicago is ⅝ inch wide.

How does the grip connect with the rope?

It is so arranged that while the rope is always connected with a portion of the grip rod, it does not move the car until the grip or clutch is forced upon the rope, when instantly it moves at the speed fixed for the movement of the rope at the engines. When the rope is grasped by the grip, the car must instantly move at the speed of the rope. The momentum is checked by relaxing the grip hold, and putting on brakes in the ordinary manner.

You say the open slotway is ⅝ inch wide; can it be crossed safely by horses?

It cannot. The slot just takes in the calk of a horseshoe when crossed at right angles. The calk gets into the slot, and unless it is withdrawn vertically it wrenches the shoe from the foot; the slot being a fulcrum and the horse's leg a powerful lever, many horses have been seriously injured by wrenching the leg in this process. I saw a horse injured by catching the calk of his shoe in the slotway and the shoe violently wrenched off, straining the cords and laming the horse. I heard of many similar occurrences.

At what speed do the cars move?

It was fixed at 6 miles an hour at times when I was watching its movement at the engines.

Did it maintain that speed?

It did at times; but frequently, when all the cars were connected—which could be discovered instantly—it slowed down to 3 miles an hour; this was during the hours of heavy traffic. At times during the middle of the day the speed was 6 miles an hour for a considerable time.

Was the service constant and uniform?

It was not; very frequent delays occurred by giving out of grips or their bearings; cars lost their hold on the rope and had frequently to be moved by horses, which are stationed along the road at intervals to meet such contingencies, as I was informed. On one occasion, when I was on the cars the passengers got out and pushed them out of the way, there being no horses just there to attach; the grips were disconnected, and car lifted to other track.

How frequently did you see the traffic impeded on the cable road?

Every day while I was there; two or three times a day on an average, from half an hour to several hours; and I was compelled to walk about two miles on one occasion, as the traffic on the road was impeded for hours; no other means of transit being supplied, I with many others walked.

Were there delays referred to on the straight track or on curves?

They were on the straight tracks.

Does the system work successfully around curves and switches?

It does not; the principal curve in the Chicago system is from State Street through Lake Street to Wabash Ave. and back again to State Street at Madison. On that circuit the speed was not more than 2 miles an hour, and was effected with great difficulty, horses often being used to move the cars. I saw them doing this every day; the effect was to block all other traffic on the street.

Is that a crowded portion of the city streets?

It is. Loaded trucks and wagons are constant on these streets.

Did the cars adjust themselves to the speed of trucks?

They did not. Truck travel is not over one to one and a half miles an hour, and the speed of the rope at 2 miles, even, cannot be adjusted to their rate, as the movement of the rope cannot be graduated to any speed other than that fixed at the drums or cylinders.

Do vehicles travel on the roadway?

They more frequently avoid it. Although the streets are much wider than in New York, they were at times compelled to take the tracks, and very often to cross them.

Did any collisions occur?

Frequently. I saw them daily. They would endeavor to stop the cars, and move at graduated speed, but the instant the grip caught they would jump to this fixed speed of the rope, and heavy trucks loaded with tons of freight were struck and their load scattered over the street. The system cannot be adjusted to the movement of ordinary street traffic.

You say that the grip facings became worn, and that they required frequent renewals?

I was told by the manager of a grip car, when he lost his grip, that the facings had been renewed when he started from the station, and had become exhausted before he reached the other end of the road.

Did you observe the method of crossing other tracks, and how the system worked on switches?

Yes; in the case of tracks crossed at one place, the rails of the other road were cut entirely through, the whole crossing of both roads set in an immense iron platform, to hold the whole frame, the slotway was cut and made continuous across and through the rails of the other road. At other places the grip is released on crossing the track, and is to be caught again after passing the obstacle. The same method is adopted at switches.

Is the reconnection of the grip reliable?

It is not; it often fails, and causes delay, when horses have to be attached to get over that portion of the track.

Does the rope ever break?

Yes; it has broken frequently from various causes, which, of course, suspends all traffic on the road by its system until it is repaired.

How long does it take to repair such breaks?

Several hours; sometimes a full day, when the road can only be operated by horses.

What are the causes of the breaks?

The wearing of the rope, which is unavoidable from the excessive friction of the system; sometimes by being cut off with a too sharp application of the grip; but the breaking of wires is constant, and persons are stationed at the cylinders to meet the rope as it passes in from the roadway, to cut off with shears the protruding wires which have been broken, as such broken wires will soon bunch and stop the whole movement, in which case the bunched portions must be cut out and repaired.

Does the Chicago system attain what might be called rapid transit?

It does not; it is not rapid; the average speed is not equal to that of a good horse car service. It cannot make up for lost time by extra speed after delay, but must move at that fixed by the engines. This difficulty is radical and cannot be overcome where other traffic is allowed.

Did you discover any advantage in the Chicago rope traction system over horse cars for street service?

I did not; it is not rapid; it is uncertain; it cannot be graduated to movement of street travel; it is extremely dangerous, collisions cannot be avoided unless it has a clear roadway and other vehicles avoid its track. I see no possible advantage in the system in any particular for streets, but my observation compels me to decide that it is entirely impracticable for the crowded streets of any city. I have used rope traction for inclined plane service and made my examination with the utmost care to determine whether I could apply it for street railways, and am forced to the decision that no results are attained as an equivalent for the great expense, and that even were it less costly than a horse service, it would not be practicable for city streets in constant use by other vehicles.

A GERMAN journal gives a malleable alloy composed of 60 per cent. of copper, 38⅔ per cent. of zinc, and 1⅓ per cent. of iron. This alloy has the property of being readily worked when warm. It can then be employed for constructing various pieces of lock work, which are commonly made of iron, and which, when made of this alloy, would be much less subjected to rust.—*Chron. Industr*

CORRESPONDENCE.

To the Editor of the Scientific American:

In SCIENTIFIC AMERICAN SUPPLEMENT of Feb. 16, 1884, in an article called "Some of the Properties of Water," by William W. Williams, which I presume was copied from *Cotton, Wool, and Iron*, the name should have been "Wm. J. Williams." There was a slip of the pen in the original MS. which made me say that water at 60° Fahr. will dissolve its own weight of Epsom salts, etc.; it should have read, "*Water at 212° Fahr. will dissolve its own weight of Epsom salts, but at 60° Fahr. it will not do so.*"

In your copy, in that part referring to the temperatures of water and their weights, I am made to say that for every additional degree of heat above 57° it increases in weight; the original says *decreases*.

Among the saturated solutions of different substances of their boiling points and corresponding temperatures in steam boilers, under given pressures—of washing soda the SUPPLEMENT says: "Temperature of water in a steam boiler under 2 lb. pressure, 209°+;" the original says, 219°+.

When I wrote the above named paper I had no idea or the slightest desire for it to become public; but my friends insisted that it should be published in some mechanical paper. When I assented, it was with the understanding that my name was not to appear; but a friend to whom I was just introduced "gave me away," as the saying goes, but got my middle initial wrong; since it has become public, I feel like being set right on all points.

I am, yours very respectfully,

WM. J. WILLIAMS,

President Merrick Association Stationary Engineers.

Philadelphia, Pa., Feb. 22, 1884.

CERAMIC PHOTOGRAPHY.*

By A. L. HENDERSON.

To no single individual or country can the credit be given for the discovery of pottery, porcelain, or ceramics. The term "hard" or "soft" porcelain is twofold. The "hard" is a substance that is brittle or difficult to fuse; the "soft" is quite the reverse, differing only by the amount of solid body or infusible material contained in the flux or glaze. All vitreous substances laid on or supported by metal are usually called "enamel." It is the soft porcelain or enamel that I will have specially to deal with to-night. It is to Mr. Lafon de Camarsac we are indebted for ceramic photography, he being the first to produce the photographs fixed by fire (about 1856).

His method, so far as I can learn, has never been published, and is still considered a secret process. Many operators have called upon me offering their services, and who professed to have been working on enamel in M. Camarsac's employ, but in no case have they produced presentable results. His (Camarsac's) method, I have little doubt, is what is usually called the "dusting on process;" that is, a glass plate is first coated with collodion, and then with a mixture of sugar, honey, and bichromate of ammonium. The plate is exposed under a transparency, the affected parts becoming somewhat hardened or less tacky or hygroscopic by the action of the light. The plate is then dusted over with an enamel color finely ground, when the image will appear, the color adhering to the moist portions. It is then placed in acid and water to remove all soluble matter, transferred to the permanent support, and placed in the kiln.

When the carbon process was introduced, at the first glance it seemed as if enamel or porcelain photography would receive a great impetus; but the difficulty in burning off the gelatine was almost insurmountable. Mr. Firling, of Dorchester, about sixteen years ago, showed me some promising results by the carbon process. Some later advances, however, have been made in this direction by using saponaceous substances to prevent the cracking and blistering of the gelatine.

The second method of producing vitrifiable photographs is known as the "substitution process;" that is, a transparency is taken on wet collodion, and various chemicals are allowed to react on the silver, thereby depositing and substituting medals in lieu of the silver, which, if left in the picture, would give a disagreeable tone. (Silver gives a bright yellow color.) Of the two processes named I would give preference to the "dusting on," as a greater range of color can be obtained.

The third and last method is that devised by the author of this communication. It is with some difficulty I can find a name for the method. I might call it a "mongrel process," as it comes between the first two.

Here I have a collodion transparency very thin, as you will see; the high lights are perfectly clear glass, and the shadows not heavy—such a transparency as would look best as a lantern picture. It was developed with—

Sulphate of iron	5 grains.
Acetic acid (Beaufoy's)	15 minims.
Water	1 ounce.

Saturated with common alum.

I will place it in a solution of a platinic salt, prepared as follows:

Bichloride of platinum, or its compound	5	parts.
Bichloride of tin, or its compound	30	"
Iodine of potash	30	"
Iodine, to saturation.		
Acid (such as hydrochloric)	960	"
Silicate of potash	20	"
Acetate of lead	40	"
Water	8000	"

Saturate the whole with boracic acid.

The platinum and tin will, to a certain extent, take the place of the silver, as well as depositing on what is already there. I can at any moment apply solvents—say nitric acid—that will not act on the platinum, and remove the silver; and even after its removal the depositing action will still proceed. Should the silver be in a form (say chloride or iodide) that will not dissolve in nitric acid, I can oxidize or reduce them to the metallic state by heat, so that they will be amenable to treatment. It is seldom I have to resort to the removal of the silver, as there is such a small amount present, and it improves the tone rather than otherwise.

As soon as there is sufficient density I remove the picture from the solution, immerse it in a five per cent. solution of sulphuric acid and water, saturated with boracic acid, and transfer it to the enamel tablet, dry it, and it is then ready for the fire. If one of the films be left in water for some days, a peculiar action takes place; that is, the image will

* Read before the London and Provincial Photographic Association.

entirely disappear, leaving no trace of its color in the water; and if the enamel, when placed on its permanent support, be left exposed, unfired, to the air for some time, the coloring matter will become soluble in water. As a rule, it is better not to add any flux or glaze over the picture. Great danger is likely to arise, as, the flux or glaze being so much easier fused, blisters might occur; and, although it gives a little greater depth to the shadows, a much deeper print is necessary. One of the secrets of photo-enameling is, to put the glaze on the plate first.

Many here believe that the whole secret lies in the firing. I will fire one so that it is melting. I will now press a knife into it, while in the fire, to show what state of fusion it is in, at the same time showing that there is no loss of color. I can place a photograph on (say) a Minton's tile, and allow the image to sink into the glaze. I remove the image, leaving an impression on the porcelain, which might be inked and printed like a copper plate. These enamels may be colored by any artist with very little practice. Here is one—the first attempt. I think you will say it is fairly good. Of course a little knowledge is required as to which colors are to be applied first. To touch up an enamel, or remove spots in the fired picture, I use a brown enameled color mixed with a small quantity of sesquioxide of iridium, rubbed up with spike oil of lavender, refiring to fix the touching.

I may as well mention a few of the colors produced by some of the oxides: Tin and arsenic give a white; gold, red or purple; copper, green or red; silver and titanium, yellow; cobalt, blue; iron, reddish yellow; platinum and tin, various tints of brown; iridium, black. The mention of iridium recalls an amusing circumstance. I had occasion to send to a large London dealer for a few grains of an iridium salt for experimental purposes. My messenger brought back an entirely different compound, and on my calling personally for an explanation, I was informed that they sent me that which was usually sold for photographic enameling purposes as "Henderson's chloride of iridium." "Well," I said, "my name is Henderson, and I am a photo-enameler, but I have not been using iridium." The reply was that many persons called asking for the iridium similar to that used by Henderson. The moral is: If you wish to make dynamite, be careful where you buy your chemicals.

RELIEF PRINTING BLOCKS FROM PHOTOGRAPHS.

THERE are probably many of our readers, especially those who have but lately directed their attention to photography, who are not aware by what exceedingly easy means a photograph may be converted into either a relief or intaglio block, capable of giving impressions in printer's ink. We propose here to describe what we consider the simplest of all the processes for effecting this end, and preface what we have to say by remarking that although simple, it is capable of giving results of great excellence. By its means we some time ago produced from pen and ink drawings several printing blocks which were employed in the illustration of a treatise on physiology.

Having obtained one or more plates of perfectly flat and well polished glass, not exceeding 4×5 inches, as a commencement for this kind of practice, let them be made quite clean, and then coated with a solution prepared according to the following directions. Into a glazed porcelain dish place a small quantity of gelatine—say half an ounce or more—and pour upon this rather more cold water than suffices to cover it thoroughly. Allow it to stand for ten or twelve hours, or until it has absorbed all the water possible. Now pour off the remainder of the water, and place the vessel in a warm oven, or set it in another vessel of hot water for a few minutes, by which the gelatine becomes liquefied as soon as warm.

Having prepared a saturated solution of bichromate of potash, add enough of this to the gelatine solution to make it of a deep amber color. The precise proportion is of little consequence; only too much must not be added, else it will crystallize out when the film becomes dry. This can be readily ascertained by spreading a little on a strip of glass, and warming it before a fire until dry. If the gelatine film is transparent and of a rich yellow color, it is right; if it dries opaque, owing to the crystallizing of the bichromate, add a little more gelatine from a small supply which should be kept in reserve. This operation should be conducted in a room from which bright daylight is excluded, although it is but little affected by light so long as it remains wet. It must be filtered through cloth or felt into a clean glass bottle, in which, if kept corked, it will remain good for a considerable period, as the bichromate acts as an antiseptic. Should an additional antiseptic be considered desirable, especially during hot weather, a few drops of creosote or carbolic acid will insure its preservation for several months.

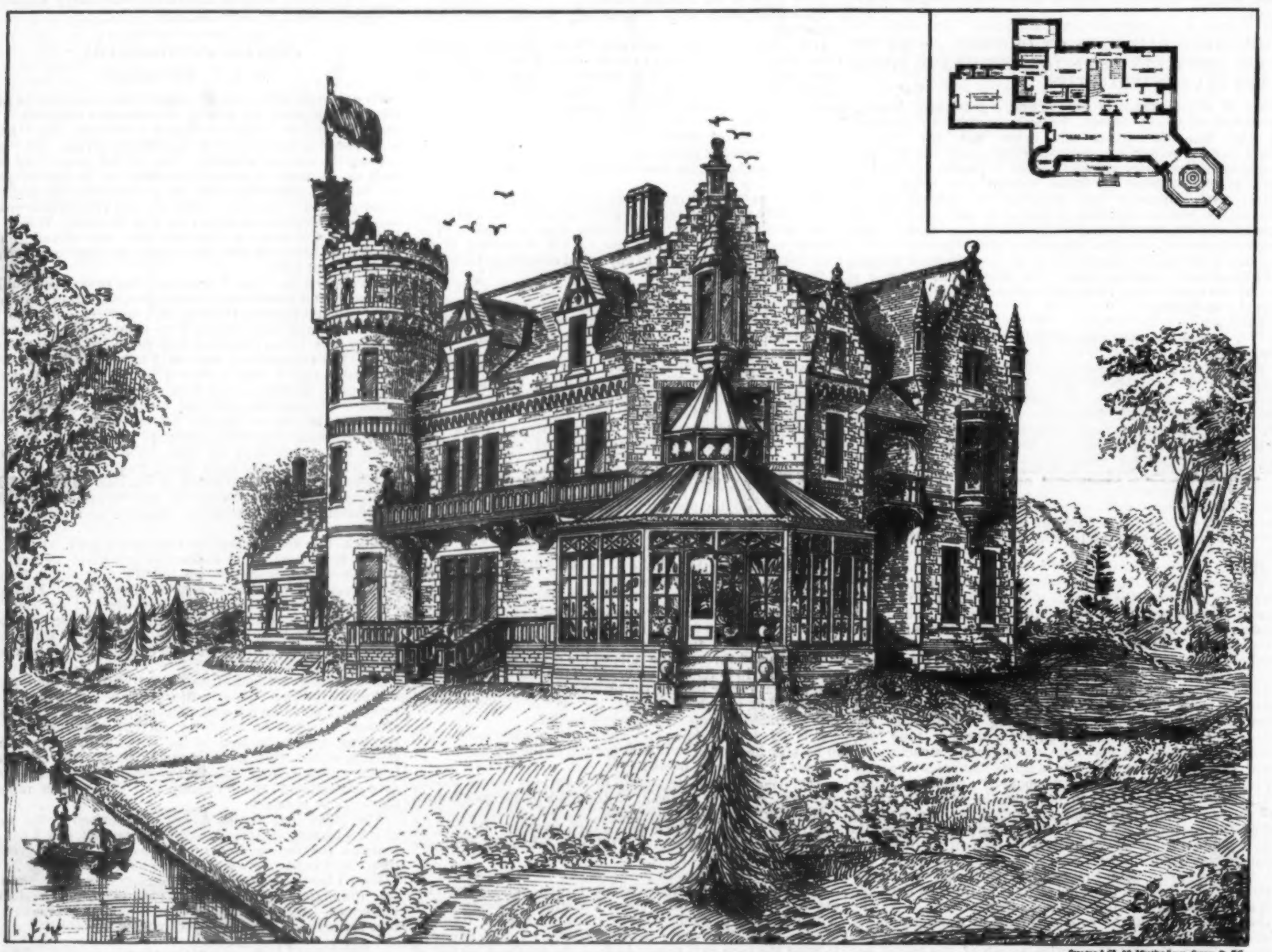
In coating the glass, place it level, and then pour a small pool on the center. This must be guided over the surface by means of a slip of paper or a strip of glass. Concerning the drying: For a long time we allowed the plates to dry spontaneously, which occupied several hours. But one evening we tried the effect of drying by heat, which we did by laying a coated plate on the flat top of a kitchen stove, by which the gelatine was made quite dry in a few minutes. The plate thus treated eventually gave such a good result that we have ever since preferred a quick drying. Plates so prepared will keep good for several days; we have used them after being kept four weeks.

In making the first experiments with this process, the negatives should be as intense as possible, and be obtained from pen and ink drawings or printed matter. The sensitive side of the glass having been placed in contact with the negative in a printing frame, let them be exposed to a good light from five minutes to a quarter of a hour, according to the strength of the light and the density of the negative. The plate must then be brought into the dark room. It is now seen to be impressed with a visible image of the subject of the negative, the action of the light having been to darken the film; but with this discoloration we need not at present trouble ourselves. It does, however, concern us to know that wherever the light acted when in contact with the negative, there the gelatine was rendered insoluble, and no longer amenable to the influences of water, the portions protected from the light remaining soluble as before. As we do not want to dissolve such portions away, but only to let them absorb water so as to swell up, place the impressed glass, face up, in a flat dish, and pour upon it some cold water. In a few minutes, if taken up and examined, by blowing off the water with a sharp puff of breath, the image will be found standing in relief. It is well to allow it to remain in the water, until by the swelling of the unaltered gelatine from the absorption of water a considerable degree of relief has been obtained; after which it may be removed, and the surface dried by blotting paper.

The plate now presents a beautiful appearance. Assuming the negative to have been made from printed matter, the letters, or black marks of the original, are seen polished and bright and of the most perfect form, sunk down at a considerably lower level than that of the remainder of the gelatine surface, and it becomes immediately apparent to the dullest capacity that if a cast were taken from this surface such cast, owing to the letters standing in high relief above the general surface, and being also reversed, would, if inked and printed from a typographic press, yield impressions precisely equal to the original, subject to any alteration in dimensions caused by taking the negative larger or smaller than the original.

To obtain a cast from the gelatine surface, either of the two methods may be adopted; and beyond indicating their nature, we shall not at present dwell upon this part of the subject. One is to level the plate, wrap a strip of stout paper, half an inch wide, around it, and pour in a little very fine and rather thin mixture of plaster of Paris and water, a few grains of alum or protosulphate of iron having been previously dissolved in the water. With a soft hair brush remove all air bubbles that may be formed, and brush the plaster into every portion. When this has partially set, pour in a strong backing of the same kind of plaster without any alum, and place aside till quite dry. The hard plaster will come away readily from the gelatine, and will show on its surface, and in high relief, all the details of the original. From this an electrotyper will furnish properly mounted printing blocks at a small cost.

Instead of employing plaster to take the cast, an electrotype may be taken direct from the gelatine by rendering the surface conductive, and then depositing the copper directly upon its surface.—*Photographic Times.*



RESIDENCE FOR THE HON A.C.B. BANNATYNE— —WINNIPEG MANITOBA— —ROWAN AND PAYNE—

DIVISION OF THE WEIGHT UNIT.

THE use of the kilogramme as a unit of weight has been so generally adopted that few would attempt to displace it, notwithstanding the inconvenience which results from the variations of weight with the place of the observer. A. Ledieu proposes to give it a fixed value by dividing it, in every calculation, by the ratio of the gravitating acceleration g of the place of observation to the gravitating acceleration g' of a place agreed upon, the pole for example. This mode of operation would take from the unit every characteristic of special nationality and would reduce every problem to the hypothesis of a dynamometer, with unalterable springs, gauged at the pole; moreover, masses and forces would be subjected to an identical correction. The ratio of g to g' varies from 1 to 0·9949, for corresponding elevations above the level of the sea. If this ratio is overlooked, in experiments which are performed in different countries, errors of

comparison may arise which are greater than the errors inherent in the copies of the standard of weight. Ledieu also makes valuable suggestions in regard to the units of time and space.—*Comp. Rendus.*

THE DENDROMETER.—AN INSTRUMENT FOR MEASURING HEIGHTS OF TREES.

THERE are various methods of ascertaining the heights of trees, all more or less satisfactory; but the simplest and most efficient contrivance that has come under our notice is a little instrument recently invented by Mr. Kay, forester to the Marquis of Bute, Rothesay, and which is called Kay's dendrometer. It consists of a square board (see Fig. 1), having its sides 9½ inches in length. On the sides of this square parallel lines are drawn at right angles to the edges. The square is attached by means of a pivot and clamp screw to a stout iron-shod pole about 4½ feet in length—a convenient height for taking tree measurements.

This instrument is constructed on the principle which applies to all right-angled triangles. The side A B (Fig. 1) is termed the base line, and corresponds with the horizontal line from the tree or other object intended to be measured, to the foot of the observer. The lines running perpendicular to the base line represent the altitude or height of the object either in feet, links, or yards, according to the scale by which the base line is measured. The height of any given tree is indicated on the face of the dendrometer at the point where the plumb line (suspended from the point A) intersects the perpendicular line corresponding with the distance on the base line from the center of the trunk of the tree to the observer. The figures along the top and bottom of the instrument show the number of divisions corresponding to the lines of altitude intersected by the plumb line.

Each line of altitude represented on the instrument corresponds with a unit of the scale employed, whether this scale be in feet, links, or yards. The base line is marked only at every fifth unit, thus, 5, 10, 15, 20, and so on. Whatever standard of measurement is fixed upon, whether it be in feet, links, or yards, for the base line, it is of course understood that the lines of altitude must be fixed to the same scale. The divisions on the face of the instrument are 150, but if at any time it be desired to ascertain the height of an object above 150 feet, the divisions of the instrument must be termed yards, when, of course, a height of three times 150 feet (450 feet) can be measured.

The mode of using the dendrometer is as follows: Suppose the object to be measured be a tree. The operator must first place himself at a sufficient distance from the tree, so that the extreme top of it can be distinctly seen. Note must then be made of the distance from the center of the bole to the staff of the dendrometer. At this point (where the operator stands) the staff of the dendrometer is to be fixed in the ground. Then setting it in the direction of the tree, turn the square face of the instrument (which works on a pivot fixed on the upper angle) until the plumb line falls direct upon the line A B (Fig. 1). Fix the square in this position by the clamp screw, and then look through the "sight" (the perforation running through the square from C to A, Fig. 1), and mark the place on the tree where the line of sight cuts the tree, as at B, in Fig. 2. This point (B) will give the level corresponding to the height of the observer. Next loosen the clamp screw and turn the square until the line of sight cuts the extreme top of the tree, then tighten the clamp screw again. The plumb line will then be seen to make a triangle with the base and altitude lines, as shown in Fig 1. The height of the tree will be indicated by the number of the line of altitude, which is intersected by the plumb line, on the base line corresponding with the measured distance from the tree.

The diagram (Fig. 1) shows clearly what takes place during an observation. Suppose the base line from the center of the tree trunk to the observer measures 50 feet, and after "sighting" the top of the tree the plumb line falls over the square in the manner indicated in the diagram (the upper figure), the height of the tree measured would then be 25 feet. Again, if the base line measured 100 feet, and after "sighting" the topmost point of a tree, the plumb fell across the square, as in the lower figure in the diagram, the tree would be 50 feet in height. Of course, in every case the height from the ground to the observer's eye must be added to the height read on the instrument.

In measuring reclining trees or other objects, care must be taken not to measure the base line from the center of the tree trunk, but from point on the ground perpendicular to the highest part of the tree. This point may be ascertained by holding a plumb line between the eye and the tree, and marking on the ground the place thus indicated, as at B, Fig. 3. On finding this point perpendicular to the highest part of the tree, the observer may proceed as in the preceding instructions. It will thus be seen that in measuring objects not exactly perpendicular, some care is necessary in the operation, or the measurements will be inaccurate. In the case of ascertaining the height of an object, as, for instance, that represented in Fig. 3, if the base line were measured from the center of the bole, instead of from the point, B, the observed height would be too great. In short, if the base line were measured from the center of the bole on the side to which the tree is leaning, it would give too great a height; and on the other hand, if the base line were measured on the side the tree is leaning from, the height so ascertained would be less than the true height of the tree.

Measuring flat topped trees.—In measuring the height of round or flat-topped trees, the observer must choose a station sufficiently distant, so as to fully see the highest part. If viewed too near, as at A, in Fig. 4, it is impossible for one to see the highest part of the tree, and the result is that the height is greatly increased. Therefore, in order to avoid such errors, the object should be viewed as far back as possible, so as to obtain a view of the highest point right over the true perpendicular, or in the event of this not being possible, the perpendicular and height of some definite point may be ascertained, as in Fig. 3. The height of any part of a tree or other object may be ascertained by subtracting the result of one observation from that of another. This instrument possesses many advantages; it is simple, no calculation being required; the height of any tree or other object can be ascertained at any convenient distance, and by it the height of any portion of a tree, such as the height of the trunk, can be ascertained from one station. It is, moreover, light and portable—not its least recommendation for an instrument of the is kind.

It has recently been awarded a first class silver medal by the Scottish Arboricultural Society—a sufficient proof of its efficiency.—*Woods and Forests.*

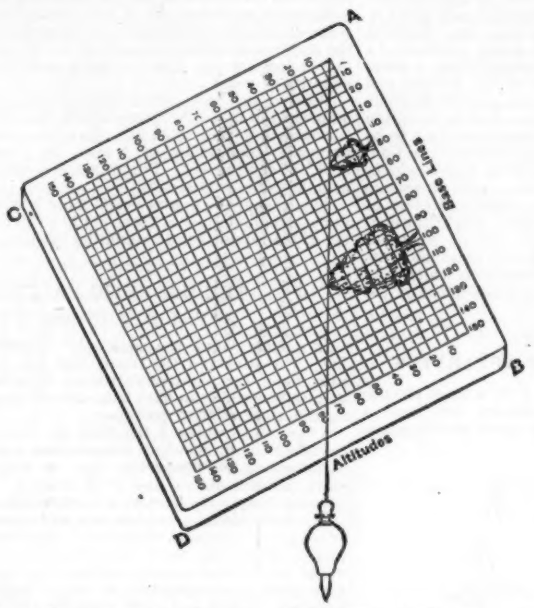


FIG. 1.—Square face of instrument. On the square itself the altitude lines are marked at every foot, the base lines at every 5 feet.

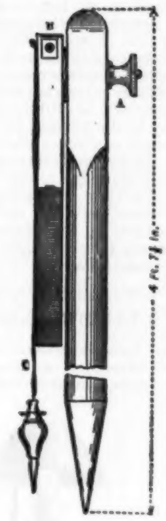


FIG. 5.—Side view of Instrument. A, clamp screw; B, perforation for taking the sight; C, plumb line.

THE DENDROMETER.—AN INSTRUMENT FOR MEASURING HEIGHTS OF TREES.

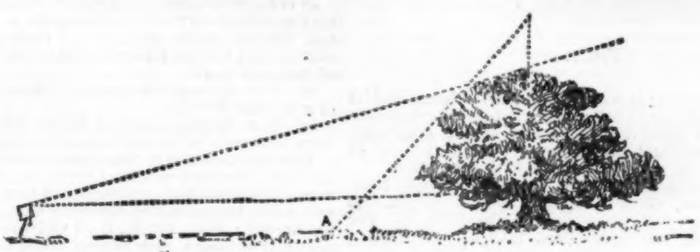


FIG. 4.—MODE OF MEASURING ROUND-HEADED TREES.

FIG. 2.—MODE OF MEASURING TREES QUITE PERPENDICULAR.

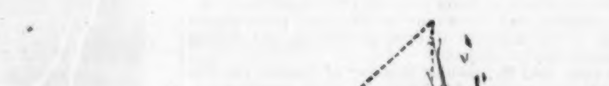


FIG. 3.—MODE F MEASURING RECLINING TREES.

THE DECAY OF BUILDING-STONES.

MR. ALEXIS A. JULIEN, of the School of Mines, Columbia College, sums up the results of a series of papers read before the New York Academy of Sciences on the decay of building-stones as follows:

If a rough estimate be desired, founded merely on the observations made of the comparative durability of the common varieties of building-stone used in New York city and vicinity, there may be found some truth in the following approximate figures for the "life" of each stone, signifying by that term, without regard to discoloration or other objectionable qualities, merely the period after which the incipient decay of the variety becomes sufficiently offensive to the eye to demand repair or renewal.

	Life in years.
Coarse brownstone	5-15
Laminated fine brownstone	20-50
Compact fine brownstone	100-200
Bluestone	Untried, probably centuries.
Nova Scotia stone	Untried, perhaps 50-200
Ohio sandstone (best silicious variety).	Perhaps from one to many centuries.
Limestone, coarse fossiliferous	20-40
" fine oolitic (French)	30-40
" " (American)	Untried here.
Marble (dolomite), coarse	40
" " fine	60-80
Marble, fine	50-200
Granite	75-200
Gneiss	50 years to many centuries.

Within a very few years past it has become frequent to introduce rude varieties of rusticated work into the masonry of buildings in New York, or to leave the stone rough and undressed in huge blocks, especially in the basement or lowest stories, where it is under close and continuous inspection, and the results of its decay will be disguised by its original rough surface. Although there are certain large buildings in which such a massive treatment of stone may be appropriate, its common use, with stones of known feebleness or lack of durability, is a disingenuous evasion of responsibility and a mere confession of ignorance, want of enterprise, and despair, in regard to the proper selection of building material and in regard to its protection.

Finally, it may be pointed out that many of the best building-stones of the country have never yet been brought into New York; for example, silicious limestones of the highest promise and durability, allied to that employed in Salisbury Cathedral; refractory sandstones, like some of those of Ohio and other Western States, particularly fitted for introduction into business buildings in the "drygoods district," storage-houses, etc., where a fire-proof stone is needed; and highly silicious varieties of Lower Silurian sandstones, such as occur near Lake Champlain, quartzitic and hard to work, like the Craigleith stone of Edinburgh, but possessing the valuable qualities of that fine stone in resisting discoloration, notwithstanding its light color, and in remarkable resistance to disintegration.

As it is, we have many and need many varieties of stone for our various objects, but we do not know how to use them. It is pitiable to see our new buildings erected in soft and often untried varieties of stone, covered with delicate carvings of foliage and flower garlands, which are almost certain to be nipped off by the frost before the second generation of the owner shall enter the house. It is now time for one that who loves stone to express his indignation at the careless and wasteful way in which a good material is misused.

THE BAUME HYDROMETER SCALE.

By John Tagliabue.

It is now some years since the question of value of the respective degrees of the Baume hydrometer scale greatly increased in public interest, by reason of the almost universal use of the scale, and the immense importance of certain products, whose commercial value is almost entirely determined by its indications. It was only a year or two after the petroleum trade had become a gigantic interest, when the scale of the light Baume hydrometer (which was required as a measure of the gravity of the article both in its crude and refined condition) was discovered to be so various in its character that no two instruments could be found, if from different makers, to give the same indications; and when this discrepancy became the subject of investigation it was soon perceived that no two authorities agreed upon the subject, that the tables all differed each from the other, and thus we were all at sea as to the actual meaning of any given degree.

At once the cause of this extraordinay fact became a subject of inquiry, and after a pretty diligent search into what existed of the literature and history of the Baume scale—a scale which had attained a use all over the world—it was found that no scale so entirely devoid of a fixed basis existed—that is to say, none so wanting in data—by which two persons performing the same operation would be certain to reach the same results.

Its history and all that constitutes its bases may be given in a very few words: Baume took pure water at 60° temp. (or rather at 15° Cent.) for his zero, and weighing 15 parts common salt and 85 parts of water, and carefully dissolving the one in the other, keeping of course the solution at the same temperature, he marked this as 15° upon the stem of the instrument which he floated.

The writer is not quoting the statement of any one work, but as nearly as he can give from memory what he understands to be the substance of all he has been able to find.

Now, in no place has the writer been able to find it stated whether any idea entered the mind of the originator of this scale as to the perfectly cylindrical shape of the stem of the instrument, or, if the idea was present, whether any account was taken of it. It is well known to makers that just as the irregularities in the bore of a thermometer tube cause a difference in the degrees, unless taken into account and provided for, so the stem of a hydrometer if not perfectly cylindrical (which is almost impossible in glass) will produce a difference, greater or lesser, according to the greater or lesser perfection of the cylindrical shape of the stem. In other words, assuming that we had two stems as nearly perfect in their cylindrical shape as may be, and we made the precise experiment which is given as Baume's, we should doubtless reach a similar result each time; but it must be remembered that if the least difference is found to exist in the cylindrical shape of the stem, the likelihood of similar results is at once destroyed; this is especially the case when it is remembered that we have so small a part of the scale furnished to us as the entire data or basis, *and all the rest as deducible from this;* it must be obvious that whatever error is obtained from the first quantity or part of our scale will be increased as often as the number of times we repeat the quantity, or, rather, as we increase the length of our scale. From this source alone it is not unlikely that all the errors existing in the books for the past fifty years have arisen, and when we add to this the more or less careless workmanship of makers, not always the result of ignorance, but sometimes from a desire to produce their work cheaply, it is not difficult to perceive how nearly impossible it has always been for compilers of tables, writers, and chemists to procure instruments that could by any likelihood enable them to reach similar results.

These being at length found to be well established facts, and another fact being not less certain—viz., that the universal use of the instrument precluded the idea of doing away with it—it became a very urgent question how to render its indications so nearly uniform as to stop the continually occurring disputes that from time to time were becoming so vexatious in the business of buying, refining, and dealing in petroleum and its products.

In the year 1862 Mr. Samuel Donner, of Boston, came to New York, and succeeded in forming a trade combination, known since as the U. S. Petroleum Association, the chief object of its formation being at that time the very question which we have here before us—"How to fix the value of the respective degrees of the Baume scale?"

It was by this association agreed after due deliberation that, as all the authoritative works differed from each other, and that consequently no fixed basis for a correct scale existed, the specific gravities given in the U. S. Dispensatory—a work perhaps the most accessible to every one, as being found in every drug store in the country—should be adopted, and the makers of the instrument required to conform to these figures. This very sensible proposition being adopted, it is not far from the truth that from that time to the present there has scarcely arisen a dispute in the petroleum trade upon this point, which previously had been a source of constant trouble and vexation.

In like manner in the year 1875, after years of vexatious difference, which from time to time gave honest manufacturers the most intense annoyance, from the fact of less principled competitors in trade guaranteeing to supply acid of a certain gravity (Baume 66°) while this gravity (as given in the books) was almost unattainable, caused the manufacturing chemists to form an association, and one of its first efforts was to appoint a committee to examine the question of the Baume scale for heavier liquids than water (the Petroleum Association having only concerned itself with the light liquids). The report of this committee was afterward published and a table appended, which was practically and precisely the same step that in 1862 had been so successfully adopted by the Petroleum Association. In settling for itself that a certain weight should be Baume 66°, rather than the heretofore quite uncertain weight ranging all the way from sp. gr. 1·760 to sp. gr. 1·850, a great step was undoubtedly made by the trade.

To the writer it seems evident that if the facts be as he has stated them (and they can be verified by any one who cares to look into the subject), no better action could be taken than this, which in two very important instances has been found so beneficial in giving to the world, in place of a series of figures meaning nothing of definite value, a series of figures every one of which bears a strictly definite and veritable value, the step in advance seems so great in all its bearings, that it would seem necessary to call to its condition only a little thoughtful attention to at once perceive it to be the only feasible method of settling the much vexed question, not by presenting to the chemist or physicist tables which, however interesting, can under the circumstances possess no value whatever, but by prevailing upon some institution of learning, such as Columbia College or Yale, to take the matter in hand, with a view to confirm or correct what has above been presented as fact; and then to issue under its own authority a table in accordance therewith which may henceforth be deemed by all parties as a settlement of the question.—*Independent Record.*

RADIGUET'S ELECTRIC LIGHT APPARATUS.

We have just been experimenting with a small electric light apparatus formed of an incandescent lamp and a battery of four elements constructed by one of our ingenious

Fig. 1.

makers, Mr. Radiguet; it was a two candle lamp, and it operated for fifteen hours before the pile became completely exhausted. The general arrangement of the apparatus, which is not very high-priced, appears to us worthy of recommendation, so we shall describe it to our readers.

The luminous focus consists of a small incandescent lamp of feeble resistance, which is mounted upon a support that receives at its lower part two conducting wires (Fig. 1). For opening or closing the circuit, that is to say, for lighting

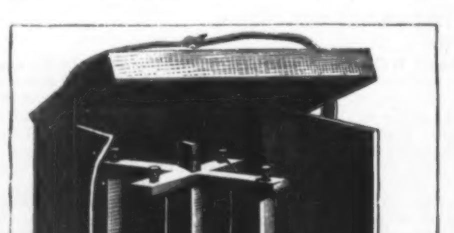


Fig. 2.

or extinguishing the lamp, the latter is provided with a small commutator. The lamp is also provided with a movable shade for throwing the light upon the desk.

Mr. Radiguet's pile is derived from that of Poggendorff. It consists of an external earthen vessel containing a concentrated acid solution of bichromate of potash into which dip three strips of retort carbon to form the positive pole. A porous vessel placed in the center is filled with dilute sulphuric acid. Into this latter dips a piece of well amalgamated zinc to form the negative pole. The zinc may remain immersed without inconvenience while the current is open.

According to measurements of these elements that have been made by Mr. E. Hospitalier, the electromotive force is 2·13 volts.

Mr. Radiguet has arranged the four-element battery, designed to operate the lamp, in a box having four compartments, and provided with two handles that permit of its being easily carried about. The zincs can be raised or lowered in their respective vessels all four at once. They are, as shown in Fig. 2, fixed to a wooden cross-shaped support that slides up and down an upright provided with a rack. In our engraving the zincs are represented out of the liquids. The whole is contained in a box which does not exceed 0·4 m. in height, and which is capable of holding likewise the lamps and the bottles of salt for preparing the liquid.

The salts are composed of acid bichromate of potash for forming the external liquid and bisulphite of potash with the addition of sulphuric acid for the porous vessels. It is only necessary to dissolve these salts in the necessary quantity of water.

Where a person is not afraid to handle acids, and where he desires to make the preparations himself, the following formulas are recommended: External vessel—water, 450 grammes; bichromate of potash, 70 grammes; sulphuric acid, 150 centimeters. Porous vessel—water, 175 grammes; acid, 20 cubic centimeters.

The level of the porous vessel must be higher than that of the external one. It is necessary to await the complete cooling of the liquids before mounting the pile.—*La Nature.*

THE MAGNETIC BALANCE.*

By Prof. D. E. Hughes, F.R.S.

In a paper "On the Molecular Rigidity of Tempered Steel,"† I advanced the theory that the molecules of soft iron were comparatively free as regards motion among themselves, while in hard iron or steel they were extremely rigid in their relative positions.

I have since widened the field of inquiry by observing the effects of mechanical compression and strains, as well as annealing and tempering, upon the magnetic capacity of sixty varieties of iron and steel, ranging from the softest Swedish iron to the hardest tempered cast steel.

We know already that soft iron will take a higher degree of temporary magnetism than steel, and that tempered steel retains magnetism more than soft iron; consequently, we might believe that, by the aid of an instrument which should give correct measurements, we might be able to include all varieties of iron and steel between the two extremes of softness, as in annealed iron, and hardness as in high tempered cast steel. This proved, however, not to be the case, if the iron and steel were not all annealed to one absolute standard, and if magnetized to or near saturation.

In a late paper upon the theory of magnetism, ‡ I said:

"During these researches I have remarked a peculiar property of magnetism, viz., that not only can the molecules be rotated through any degree of arc to its maximum, or saturation, but that while it requires a comparatively strong force to overcome its rigidity or resistance to rotation, it has a small field of its own through which it can move with excessive freedom, trembling, vibrating, or rotating through a small degree with infinitely less force than would be required to rotate it permanently on either side. This property is so marked and general that we can observe it without any special iron or apparatus."

In order to observe this in electro magnets, we must employ an extremely feeble current, such as from one Daniell cell, with an exterior resistance of from 10 to 1,000 ohms, and we then find the following laws hold with every variety of iron and steel:

1st. That its magnetic capacity is directly as its softness or molecular freedom.

2d. That its resistance to a feeble external magnetizing force is directly as its hardness, or its molecular rigidity.

This has proved to be the case upon sixty varieties of iron and steel furnished me direct from the manufacturers, and it was remarked that each variety of iron or steel has a certain point, beyond which annealing cannot soften, nor temper harden; consequently, if all varieties were equally and perfectly annealed, each variety would have its own magnetic capacity, or its specific degree of value when perfectly annealed or tempered, by means of which we could at once determine its place and quality.

If in place of several varieties we take a single specimen, say hard drawn Swedish iron wire, and note its magnetic capacity, we find that its value rises rapidly with each partial annealing, until an ultimate softness is obtained; being the limit of its molecular freedom. We are thus enabled to study the best methods of annealing, and to find at once the degree of softness in an unknown specimen. A similar effect occurs in observations upon tempering; from the softest to the hardest temper, until we arrive at its ultimate molecular rigidity.

We have thus in each piece of iron or steel a limit of softness and hardness. In soft Swedish iron tempering hardens but 25 per cent., while mechanical compression (such as hammering) hardens it 50 per cent. In cast steel, tempering hardens it 400 per cent., while mechanical compression gives but 50 per cent. Between cast steel and Swedish iron we find a long series of mild steel and hard iron, varying in their proportionate degree between the two extremes mentioned.

In order to carry out these researches, I constructed an instrument which I have called the magnetic balance. It consists of a delicate silk fiber suspended magnetic needle, 5 centim. in length, its pointer resting near an index having a single fine black line or mark for its zero, the movement of the needle on the other side of zero being limited to 5 millim. by means of two ivory stops or projections. When the north end of the needle and its index zero are north, the needle rests at its index zero; but the slightest external influence, such as a piece of iron 1 millim. in diameter 10 centim. distant, deflects the needle to the right or left according to the polarity of its magnetism, and with a force proportional to its power. If we place on the opposite side of the needle at the same distance a wire possessing similar polarity and force, the two are equal, and the needle returns to zero, and if we know the magnetic value required to produce a balance we know the value of both. In order to balance any wire or piece of iron placed in a position east and west, a magnetic compensator is used, consisting of a powerful bar-magnet free to revolve upon a central pivot placed at a distance of 30 or more centim., so as to be able to obtain delicate observations. This turns upon an index, the degrees of which are marked for equal degrees of magnetic action upon the needle.

* Proceedings of the Royal Society, December, 1883.

† See Supplement No. 375, March 10, 1883.

‡ See Supplement Nos. 390 and 392, June and July, 1883.

A coil of insulated wire, through which a feeble electric current is passing, magnetizes the piece of iron under observation; but as the coil itself would act upon the needle, this is balanced by an equal and opposing coil on the opposite side, and we are thus enabled to observe the magnetism due to the iron alone. A reversing key, resistance coils, and a Daniell cell are required. Great care must be taken so that the electromotive force remains a constant, as a small variation in the electromotive force gives large variations in the readings, and many important details of construction are required, in order that it shall give perfect readings for extremely small magnetic force. Still greater care is required that each specimen of iron or steel shall be annealed to its maximum.

Several methods of observation have been employed with the magnetic balance, the usual one being the one described; but interesting results are attained by observing the influence of earth's magnetism alone on the iron or steel, or we may magnetize all specimens to the same value, and note the amount of current required. We may observe the remaining magnetism after the cessation of the current or the influence of a weak current after the passage of a strong magnetizing force. These are more applicable to researches upon the cause of magnetism.

By means of this instrument I have tested 60 varieties of iron and steel, mostly in the form of wires, a wire 1 millim. in diameter, 10 centim. long, being the standard used. In all comparative experiments we require one standard form, to which all the rest must be similar in form and size; at present, we cannot readily compare a square or flat bar with a piece of wire, but if all pieces have the same form, and all are annealed to the same standard, then any difference observed between them must be due to their comparative softness, from which we can deduce its quality and place on the line from soft iron to cast steel.

Annealing not only produces softness and consequent molecular freedom, but it entirely frees it from all strains previously introduced by drawing or hammering. Thus a bar of iron drawn or hammered has a peculiar structure, say a fibrous one, which gives a greater mechanical strength in one direction than another. This bar, if thoroughly annealed at high temperatures, becomes homogeneous, and has no longer even traces of its previous strains, provided that there has been no actual mechanical separation into a distinct series of fibers.

TABLE I.

INFLUENCE OF ANNEALING UPON SWEDISH IRON, SAMPLE G.

	Degrees of softness indicated upon the magnetic balance.
Wire, hard drawn, as furnished by the makers	230°
Annealed at black heat	255°
" dull red	329°
" bright red	438°
" yellow	507°
" yellow-white	525°

From the above table, we notice that a regular increase of softness occurs, as the temperature at which it is annealed increases, the maximum being at a point under that of fusion.

Numerous methods of annealing were tried, the highest results being obtained when the iron or steel was heated as rapidly as possible to a high temperature, and cooled in a neutral surrounding or atmosphere. The facts regarding annealing as pointed out by the measurement of the magnetic capacity of iron have, no doubt, been in great measure perceived by ordinary mechanical methods; the results of my own researches may be thus formulated:

1. The highest degree of softness in any variety of iron or steel is that obtained by a rapid heating to the highest temperature less than fusion.

2. The time of gradual cooling required varies directly as the amount of carbon alloy.

Thus in chemical pure iron, rapid cooling, as in tempering, would not harden it, while steel might require several days, even for pieces only 1 millim. diameter. Slow cooling has no injurious effect upon pure iron when cooled in a neutral surrounding, consequently, where time is no object, we may employ slow cooling in every case.

A wire or piece of iron, thoroughly annealed, must not be bent, stretched, hammered, or filed, as the hardening effects of a bend are most remarkable, and the mere cleaning of its surface by sandpaper hardens its surface several degrees.

The following table shows the effect of annealing upon a series of wires, kindly furnished me expressly for these experiments by Messrs. Frederick Smith & Co., of Halifax:

TABLE II.

Marked		Magnetic capacity.	
		Bright hard drawn.	Annealed.
G	Best Swedish charcoal iron, 1st variety	230	525
F	Best Swedish charcoal iron, 2d variety	236	510
T	Best Swedish charcoal iron, 3d variety	275	503
S	Swedish, Siemens-Martin iron	165	430
H	Puddled iron best best	212	340
Y′	Bessemer soft steel	150	291
Y	Bessemer hard steel	115	172
Z	Crucible fine cast steel	50	84

The above series contains representative irons and steel of all classes; all other varieties yet tried stand between cast steel and Swedish iron, generally classed as hard cast steel, hard steel, mild steel, hard puddled iron, soft iron, Swedish charcoal iron.

From the above table it will be seen that every wire rises greatly in value by annealing, and that we could not estimate the true magnetic capacity of any iron or steel unless special attention was given that all should be annealed to their maximum.

The influence of tempering upon the magnetic retentivity or molecular rigidity has been shown in every piece of iron or steel examined, the molecular rigidity of tempered cast steel being proportional to its species of temper as shown in Table III.

TABLE III.

TEMPERING.

	Magnetic capacity.
Crucible fine cast steel tempered	
Bright yellow heat cooled in cold water	28
Yellow red	32
Bright yellow tempered in cold water let down to straw color	33
Bright yellow tempered in cold water let down to blue	43
Bright yellow tempered in oil	51
Bright yellow tempered in water let down to white	58
Red heat tempered in water	66
Red heat tempered in oil	72
Crucible cast steel annealed	84
Swedish charcoal iron annealed	525

Table IV. gives the complete results of the mechanical, chemical, and physical tests upon series of wires furnished by Messrs. Frederick Smith & Co., of Halifax.

TABLE IV.

Marked		Electrical resistance per mile of 0·40 diameter.	Tensile strength per square inch.	Magnetic capacity.			Chemical analyses.						
				Bright hard drawn.	Annealed.	Tempered hard.	Carbon.	Silicon.	Sulphur.	Phosphorus.	Manganese.	Copper.	Iron.
		Ohms	Tons.										
G	Best Swedish charcoal iron 1	191·52	28	230	525	435	0·09	trace	trace	0·012	0·06	trace	99·69
F	" " 2	198·40	30	236	510	415	0·10	trace	0·022	0·045	0·03	trace	99·70
T	" " 3	199·62	31	275	503	395	0·15	0·018	0·019	0·058	0·234	trace	99·44
S	Swedish Siemens-Martin iron	226·32	34	165	430	390	0·10	trace	0·035	0·034	0·324	trace	99·60
H	Puddled iron best best	259·92	30	212	340	328	0·10	0·09	0·03	0·218	0·234	0·015	99·11
Y′	Best homogeneous soft Bessemer steel	266·52	35	150	291	255	0·15	0·018	0·092	0·077	0·72	trace	98·74
Y	Best homogeneous hard Bessemer steel	312·69	50	115	172	60	0.44	0·028	0·126	0·103	1·296	trace	98·20
Z	Fine crucible cast steel	350·08	55	50	84	28	0·62	0·06	0·074	0·051	1·584	trace	97·41

The tensile strength and electric conductivity are those furnished me by Messrs. Smith & Co. The chemical analyses by Mr. Henry S. Bell of Sheffield; the magnetic capacity of the bright hard drawn, annealed, and tempered wires were determined by myself by the aid of magnetic balance.

In the above Table IV. there is a complete relation between electric conductivity and magnetic capacity, both progressing in a similar ratio and agreeing in a most remarkable manner.

We see that the electric conductivity and magnetic capacity have a complete relation to each other, but while in every wire measured I have found this true, it is only so when the wire has been completely annealed and free from mechanical strain, and a feeble magnetic force employed; thus the relation exists only in the limited sphere of elastic rotation already mentioned.

I believe the relation here shown between electric conductivity and magnetic capacity to be of importance in theoretical consideratsons, and of some practical utility, as we can at once find the electric conductivity of iron and steel from a simple reading of its magnetic capacity, and also show the iron most suitable for the cores of electro magnets.

[SCIENCE.]

THE NEW MORPHOLOGICAL ELEMENT OF THE BLOOD.

WITHIN recent years it has been established beyond doubt by the labors of Hayem, Bizzozero, and others, that there exists in the blood of mammals, and apparently of other vertebrates, a third type of corpuscle, differing morphologically from from both the red and the white corpuscle, and possessing certain distinctive properties of the greatest importance in coagulation. These elements were called hematoblasts by Hayem, upon the supposition that they are eventually transformed into red corpuscles. As this view is by no means established, it will be better to speak of them as blood plates, the name given to them by Bizzozero. These blood plates must not be confounded with the "invisible corpuscles" of Norris. The latter, according to the testimony of most observers, are simply ordinary red corpuscles, from which the hæmoglobin has been removed by the method of preparation. As might be supposed, the presence of these bodies was more or less clearly noticed by some of the many observers who for years past have made the blood a subject of investigation. That they escaped detection in the great majority of cases is owing, doubtless, to the very rapid alterations which they undergo after the blood is shed, unless especial measures are taken to preserve them.

To Hayem belongs the credit of their real discovery. His investigation of their form, and, to a certain extent of their properties, was so thorough, and his method of demonstrating their presence so simple, that the attention of other observers was forced to the subject; and his results were soon confirmed, with the exception of certain details of structure which are still open to investigation. On account of the quickness with which they are destroyed after the blood has escaped from the vessels, it is necessary to make use of certain preservative liquids which have the power of fixing these corpuscles in their normal shape. The solution recommended by Hayem is composed of water 200 parts, sodium chloride 1 part, sodium sulphate 5 parts, and mercuric chloride 0·50 part. Bizzozero recommends a 0·75% solution of sodium chloride, to which some methyl aniline violet has been added. Osmic acid solution, 1%, may also be used. To obtain good specimens of the blood plates, the following method is suggested by Laker:

A drop of preservative liquid is placed on the slide, and a drop of blood on the cover slip, and the slip laid quickly on the slide, so that the two drops come in contact. As many as possible of the red corpuscles are then drained off by means of a piece of filter paper applied to the slip on the side opposite to the drop of preservative liquid; or the two drops may be placed on the slide, and the cover slip laid on from the side of the preservative liquid. The one precaution which it is necessary to observe is to lose as little time as possible in transferring the blood to the preservative liquid.

Obtained in this way, the blood plates of the mammal are small, non-nucleated, discoid bodies from one-fourth to one-half the size of the red corpuscles. Hayem states that they are biconcave, like the red corpuscles, and that many of them have a slight greenish or yellowish color, due to the presence of hæmoglobin. Bizzozero, on the other hand, maintains that they are perfectly colorless and not biconcave. Mayet supports Hayem's statement with regard to the presence of hæmoglobin in some, at least, of the blood plates; while Laker thinks that the pale greenish hue possessed by them is owing to a reflection of light from the upper surface. The same tint may be observed in white corpuscles; and, furthermore, when the blood plates are collected in masses, this color does not become more distinct. Laker confirms Hayem's statement that the plates are biconcave, and says that he has often obtained from them the well known optical phenomenon shown by the red corpuscles. The blood plates occur in considerable numbers. According to Hayem, they are forty times more numerous than the white corpuscles, and twenty times less numerous than the red corpuscles. Staining reagents have but little action upon them. Water causes most of them to disappear, though some individual plates may resist its action for a long time. Dilute solutions of acetic acid or caustic alkali quickly destroy them, while a 35% solution of caustic potash is without any marked action. Laker states that in their general behavior toward reagents they resemble most the nucleus of the white corpuscle. With regard to their origin, nothing is known. That they are not simply remnants of broken down white corpuscles is evident, in the first place, from the typical form they possess, and, in the second place, from the difference in chemical composition between the two, as shown by reagents. Bizzozero has proved conclusively that they are not pathological formations arising after the blood has been shed, since he has seen and studied them in the mesenteric blood vessels of living animals.

Hayem believes that the blood plates are finally transformed into red corpuscles. His reasons for this belief are as follows:

1. They possess a similar form.
2. They have a similar chemical composition, both containing hæmoglobin.
3. The appearance of many intermediate forms between the typical blood plate and the ordinary red corpuscle, especially in certain pathological conditions—after a severe hæmorrhage, for instance.

Under these conditions, Hayem states that the plates become more abundant, and gradually return to their normal proportion as the number of red corpuscles increases. In the main, these statements are confirmed by Mayet; but, as we have said, the similarity in form, and the presence of hæmoglobin, are denied by others, especially Bizzozero; and neither Bizzozero nor Laker was able to detect any intermediate forms between the blood plates and the red corpuscles. Perhaps the most interesting result that has come out of the study of these elements is the knowledge of the important part they take in the coagulation of blood. This property has been thoroughly investigated by Bizzozero. His conclusions may be briefly stated as follows:

Liquids which have a tendency to prevent coagulation also preserve the blood plates more or less completely from destruction. Experiments made upon blood kept within the living blood vessel show that as long as the blood remains uncoagulated the blood plates are unchanged, while the rapid coagulation of portions of the blood removed from the vessel is always preceded by a destruction of the plates and the formation from them of granular masses. When a drop of blood is whipped with small threads for about fifty seconds, the threads withdrawn, washed gently in 0·75% sodium chloride solution, and then examined under a microscope in the methylated soda solution, they are seen to be covered with a layer of plates together with some white corpuscles. If the whipping is continued longer, the plates are converted into a granular mass and covered with a layer of fibrine. If this process is reversed and a slow stream of blood is allowed to pass over a thread watched under the microscope, the different stages of the process can be observed—the deposition of the

plates, their fusion into a granular mass, and the subsequent formation of fibrine. When one of these threads, to which the blood plates and a few red and white corpuscles are adhering, is added to a liquid containing the two fibrine factors, but not fibrine ferment, coagulation takes place. That this coagulation is not owing to the thread or to the red corpuscles is easily demonstrated; it must result from the addition of either the white corpuscles or the blood plates. When, however, bits of tissue rich in leucocytes—such as the spleen, lymph glands, medulla of bone—are added to the above liquid, no coagulation at all, or else a very imperfect coagulation, follows. The inference then, is that the coagulation in the first case results from the addition of the blood plates. In his latest communication, Bizzozero states that if to a few drops of peptonized plasma, which coagulates very slowly, some water or carbon dioxide is added, and the preparation is examined under the microscope, the blood plates will be seen collected into large heaps in which the individual blood plates may still be recognized. In a few minutes the plates fuse together into a granular mass which becomes vacuolated, and at this moment coagulation begins. From the periphery of the granular heaps hundreds and thousands of fine processes radiate, and form a network which slowly spreads into the surrounding plasma.

Bizzozero attributes the origin of thrombi in blood vessels to the destruction of these corpuscles. He has been able to watch the process of formation in the mesenteric vessels of living animals when a lesion of the walls of the vessels was produced in any way.

In the blood of animals with nucleated red corpuscles, Hayem has described a form of corpuscle which has properties analogous to those possessed by the blood plates of mammals. These corpuscles may be preserved for study by the use of the liquids mentioned above. They are colorless, nucleated, slightly flattened bodies, bearing a general resemblance in shape to the red corpuscles, though usually more elongated at one or both of the poles. They vary greatly in size, but as a rule are somewhat larger than the white corpuscles. They are distinguished from the white corpuscles mainly by a difference in form and by the changes which they undergo after the blood has been shed. The white corpuscles are always more or less spherical, while the plates are flattened disks. After the blood has been shed, they become exceedingly viscous, and form granular masses from which fibrous processes radiate. Their functional value in coagulation appears to be the same as that of the blood plates in mammals with non-nucleated red corpuscles.

William H. Howell.

THE ERUPTION OF KRAKATOA.*

"Sixteen volcanoes now working between the spot where Krakatoa was before, and Sebesie." Such was one of the first reports which was sent by cable to Singapore, and which we heard at Pontianak. Never before had we been so longing for news from Java, for when H.M. ship Hydrograaf steamed into the Padang-Tikar River, we heard heavy detonations and explosions like far-off shots, so that we were alarmed about Java. As we expected, our ship was soon ordered to survey the Sunda Straits. This survey was finished at the end of October, and the reader will probably feel interested to know what really has happened there.

Krakatoa has not entirely disappeared, while, till now, no new volcanoes are visible in the neighborhood. But the report that new islands were said to have arisen between Sebesie and Krakatoa is easily to be explained, for the new islands are like a mass of smoking and steaming rocks, and if seen from afar they may easily suggest the idea of a great

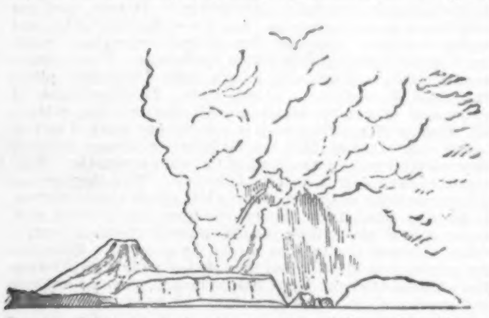


Fig. 1.—Krakatoa during the eruption of May, after a drawing of the Military Survey Bureau, Batavia.

number of working volcanoes. But, when looked at closely, it appeared that the masses of rock were composed of hot pumicestone, mixed with eruptive masses. In them there were a great many cracks and splits, in which, by the heavy breakers, steam of water was continually generated.

The northern part of the island has entirely disappeared. At what is now the northern edge the peak rises nearly perpendicularly from the sea, and forms a crumbled and rugged wall, and shows a vertical cutting (which is more than 800 meters high) of Krakatoa.

Where was land before, there is now no bottom to

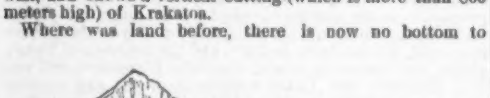


Fig. 2.—Krakatoa after the eruption in May, after a drawing of the Military Survey Bureau, Batavia.

be found; at least we could not fathom it with lines of 200 fathoms (360 meters) long. When we had quite calm weather, and steamed slowly and cautiously to and fro along the base of the peak, or had turned off steam and let the ship drift, and were busy in measuring the depth, we could distinctly see the different strata and rocks of the bare, opened mountain. Only here and there a slight trace of melted volcanic matter was to be seen, which, after half of the mountain had crumbled away, had flowed over the wall, which is still there. What remains of the slopes is covered with a grayish-yellow stuff (which, as plainly appears, had been in a melted or fluid state), full of cracks or splits from which steam is continually coming out.

In the same way steam is also coming forth from the deeper cracks of the steep wall, which is still remaining. Sometimes this is accompanied by slight explosions; at that time clouds of brown dust fly up from the cracks, and stones roll down which are often so big as to disturb the sea around the entire base of the mountain. Our entire survey of the north of Krakatoa suggested the idea that we were above a crater which had been filled with water and quenched by it, and this idea was still strengthened on observing that the decrease of depth, south of Sebesie, had principally been caused by matters which were cast out and flung away.

Almost in every place here the lead came up from the bottom, filled with black sand or carbonized dust, sometimes mixed with pulverized pumicestone and little black stones, which apparently had been in a red hot or melted state. Moreover, the soundings were very different, and the new

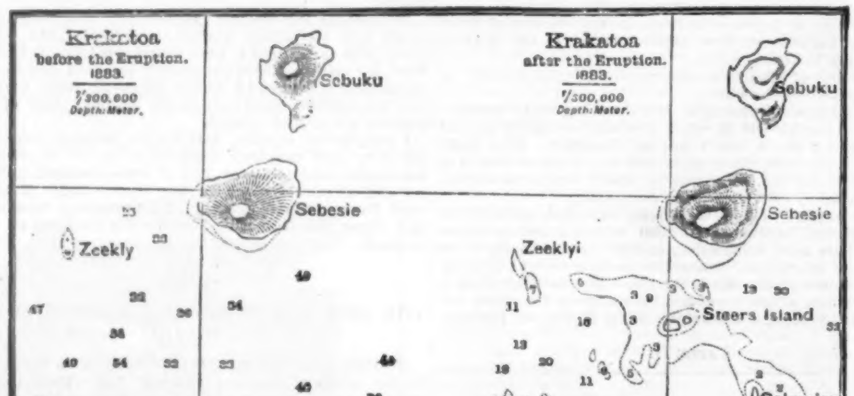
Fig. 3.—Peak of Krakatoa after the eruption in August, by M. C. van Doorn.

rocks resemble clods of substances which, when in a melted or very hot state, had contact with water. Probably such a whimsical shape of the rocks above the sea level suggests the state of the bottom of the sea in the neighborhood. The stones were still too hot to allow us to discover whether massive stones are under the pumicestone also. It was not difficult, it is true, to knock off large pieces of these rocks by a hatchet or a chopper, but when a big block fell unexpectedly down, the sailors had often to flee on account of the gases which suddenly arose. The knocked off pieces which were brought on board were still warm after they had been in the boat for an hour.

As is to be seen from the map, a great part of the lost ground of Krakatoa is found again at the bottom of the sea,

Fig. 4.—Peak of Sebesie and the volcanic rocks before it, by M. C. van Doorn.

a few miles to the north at least, if we suppose that no undulations of the ground took place. After having passed the limits to which the matters were thrown out, one finds the same soundings as were found before, and the decrease of depth is so local that the idea of an upraised bottom is dissipated at once. If such an elevation had taken place, it certainly would be remarked over a far greater extent, and be more regularly ascending and descending. The firmer and stronger part of the crater wall, the peak of Krakatoa, which is still there, remained standing when the lower and feebler part dropped down, and the water found its way into the fearful boiling pool. We cannot wonder therefore that then a quantity of steam came forth (of which we are not able to form an idea), which caused a strong explosion. The movements of the sea which followed it caused



KRAKATOA AND NEIGHBORING ISLANDS BEFORE AND AFTER THE ERUPTION, FROM OFFICIAL SURVEYS.

tidal waves, the destroying force of which was experienced in such a fearful manner at the coast of Bantam and the Lampongs.

It is also worth mentioning that a change took place in the figure of Verlaten Island; the area is now triple what it was before, though it is plainly visible that large pieces of the beach were there knocked off a short time ago.

Lang Island, in size and formation, has remained almost unaltered. The sight of these islands, which were formerly covered by a luxurious vegetation, is now very melancholy. They are now buried under a mass of pumicestone, and appear like shapeless clods of burst clay (*i. e.*, covered with cracks). After a torrent of rain, the coming forth of steam is sometimes so dense that these islands, when seen from afar, appear like hilly ground covered here and there with snow. If looking at these spots with the telescopes, one can plainly see that these white specks are formed by a great number of clouds, which issued like steam from the fissures. Sebesie is also covered with ashes up to the top—859 meters—which appear like a grayish-yellow cloth. But it seems that the cover is already less thick here, for here and there one sees the stumps of dead trees peeping out from the crust.

Sebuku shows a dreadful scene of devastation. Perhaps all that lived here is not so completely destroyed as was the case on the southern islands, but the sight of the bare fields of ashes, alternating with destroyed woods, the trees of which are all either dead or uprooted, gives one a still better idea of the destructive powers which were here at work. It is not until we come to the small islands northward of Sebuku that our eyes are gladdened by little specks of green.

I do not try to describe the scene of destruction and misery which we saw at Anjer and the villages along the coast. The papers have already reported the full particulars, and therefore I do not care to repeat melancholy facts which are already known.

It was a dreadful narrative which was related to us by a native, a lighthouse-keeper of Fourth Point, one of the few men at the lighthouse who by a wonder was saved.

When the wave approached, all fled to the tower (the light was 46 meters above the sea), which, though shaking, resisted the violent waves for a long time. It was a terrible moment, when at last an enormous rock, which was swept away by the stream, crushed the base of the tower, which then fell down. The man who was saved saw his wife and his children drowned before his eyes. He related this fact in the very resigned way of a Javanese, and considered it the most natural thing in the world that he was now obliged to light the interim light, which was erected as soon as possible.

It has been almost a month that we have been in the Sunda Straits, and even in this short period we could observe that the coasts of Bantam commence to revive. From many places, from the heavy rain, the ashes are washed down, and a fresh green appears again. Even on the beach young cocoanut trees and banana trees are shooting out between the chaos of dead trees, blocks of rocks, etc.,

Off Batavia, October 23, 1883.

* By M. C. Van Doorn, officer in command of H.M. ship Hydrograaf. Translated (and partially abridged) by E. Metzger from *Eigen Haard*, 1883, No. 51.—*Nature.*

NOTES ON NEW CALEDONIA.

New Caledonia is situated in the South Pacific Ocean between 20° 10' and 22° 26' latitude south, and 161° and 164° longitude east. It is about 7,000 miles distant S. W. of San Francisco, and about 700 miles N. E. of the Australian coast. The general direction of the island is from southeast to northwest; length, 240 miles; average breadth, 28 miles; area not quite 7,000 square miles.

About one-third of the island is composed of high broken serpentine mountains descending abruptly to the sea; a little tussocky grass and stunted bushes form there whole vegetation, and the soil is so impregnated with iron that a very scanty population of natives eke out an existence in a few favored spots.

The rest of the island is moderately fertile, though its mountainous nature precludes, as a rule, cultivation, save on the banks of rivers; this is particularly the case on the east coast; on the west the country is more Australian in its features; some considerable plains or open country are to be found in the districts of Bomail, Poga, Gomenkone, etc.

The island is surrounded by a coral reef which renders navigation in small boats comparatively easy, as it is only in the neighborhood of the passes in the reef that what sailors call "anything like a sea" is to be met.

These passes or cuts in the reef are nearly always found opposite the mouths of rivers, probably from the fresh water disagreeing with the coral making insect.

The island is splendidly watered. I have counted as many as seven streams within a mile, while as concerns climate, it is probably one of, if not the most healthy tropical country in the world; no doubt the never ceasing southeast trade wind has a most beneficial effect. The heat is seldom excessive, Europeans working under the same conditions as they would in their native places.

The population is stated in Mr. Gauharon's work to have amounted in 1881 as follows: Civilians, 2,500; officers employed, and their families, 1,041; liberes (ticket of leave men), 2,300; convicts, 6,500. According to the same author, the aboriginal census had never been properly taken until the year 1880, when it was found to amount to 35,929, including the inhabitants of the "Loyalties."

The dependencies of New Caledonia are the islands of

Huan and Chesterfield, of inconsiderable extent, and valuable only for their guano deposits, the "Loyalties," consisting of "Lifu," "Uvea," and "Mari," and the islands of "Belep," and isle of Pins, the latter at the south, the former at northern extremity of the main land; there are numerous other islands, particularly at the northern end, but of course as they lie close to Caledonia they require no special note.

From the small extent of available land the island is not likely to become noted either in a pastoral or agricultural sense. Already the quantity of cattle exceeds the demand, while the sister industry has hitherto failed in every important respect, it being impossible to grow sugar or maize, for which crops the soil and climate seem particularly adapted, on account of the locusts. Coffee grows well in certain places, and its quality, to judge from the exhibition prizes, seems far above the average, but then it is one of those crops that produces fortunes on paper and ruin in practice. Tobacco, I fancy, will be in the future principally cultivated but at present little attention is paid to it.

But if, from the above causes, Caledonia presents little temptation to the ordinary emigrant, to the mining capitalist she offers a splendid field for enterprise. The island has been described as one vast bed of minerals, and allowing a little for exaggeration the description is not inexact. Those dreary red mountains before alluded to, and from which doubtless the island took its name, contain for the most part the real riches of the colony, in the shape of nickel ore, several mines of which are being worked at this moment.

It is now seven or eight years since nickel mining first attracted the attention of local capitalists, but the difficulty of smelting, want of market, etc., caused the whole industry to be suspended for some years. Thanks, however, to the determined spirit and enterprise of the leading mine owner, a company was formed in France who reopened the works about four years ago, and have, in spite of the most extraordinary management, been prospering exceedingly ever since. This company own the only smelting works at present in the colony; they send 50 tons of 70 per cent. metal every month to France, where it undergoes the final refinement. Their mines at "Trio" produce about 600 tons per month. I do not know the average percentage of the ore, but from my own experience in other mines fancy it would be about 7 per cent.

Hitherto no nickel mine has proved permanent, all the ore being found close to the surface; still their number is so great and the quantity of ore that many produce so important, that doubtless nickel mining will become the "specialty" of New Caledonia.

The "Bel Air" nickel mine at "Houailou" gave 7,000 or 8,000 tons of good ore before being declared worked out, and the "Boa kaine" at Canala I suppose about the same. The cost of extracting ore from the "Tchio" mines, I have been told on good authority, and landing same at smelting works, is just £200 per ton.

There is also a company known as the Scotch company, but if they are doing anything, as yet I have not heard of it.

Messrs. Balland et Cie. possess or work an important mine at "Koua;" although the mine has not been working many months, I heard the manager had guaranteed a thousand tons by Christmas.

Copper mining, too, will doubtless become an important industry. Hitherto only one firm have seriously interested themselves in this particular branch of mining, and their operations have been confined to the working of the "Balade" mine, situated on the banks of the largest river of the colony, at the north end; but lately they have become sole possessors of several other rich mines in its immediate vicinity, by the simple but effective process of starving out the other shareholders and then purchasing their scrip at a nominal figure. In one of them, the "Diahot," an extraordinary rich lode was almost immediately discovered on the resumption of work. The Balade mine had, up to date, produced about 40,000 to 50,000 tons of 15% to 18% ore.

There is also a copper mine being worked, or rather prospected, called the "Boinumala," at Koumac, but the results, as yet, have not been satisfactory. The same owners possess another mine, or rather "show," which, to judge from the surface indications—if the account I heard of it was true—will turn out to be very rich; in fact, the northern part of the island seems to be as rich in copper as the south is in nickel. There are several chrome cobalt and antimony mines being worked. I know that considerable quantities of the two first mentioned ores have been shipped, but have no reliable figures to give you.

There are two gold mines declared, one of which, the Fern Hill, has lately resumed work. It was a tolerably good mine on first starting, but having given £28,000 worth of gold, was closed until lately to give time to experiment with the pyrites in which the gold is now found.

The geological formation of Caledonia is not in favor, theoretically, of its ever becoming a great gold producing country. The island seems to have remained untouched by those causes which in other lands have produced so abundantly the Silurian and other metamorphic gold bearing strata, while the formations belonging to the Tertiary system, so rich in Australia in alluvial gold found in the beds of drift, ancient river courses, made hills, etc., are altogether absent; neither have I observed the usual evidences of the glacial epoch shown by bowlder drift, furrowed or glacier grooved bowlders, and Pleistocene accumulation generally.

Volcanic action, as far as can be gathered from surface indication, seems to have been confined to the original upheaval of the island, since when the usual recent igneous rocks met with elsewhere, as derupting, interstratifying, or overlying the original strata, are completely wanting.

While the primary rocks, represented by serpentine, occupy fully one-third of the island, producing nickel, chrome cobalt, antimony, etc., the middle part is formed as a rule by the oldest metamorphic rocks, such as gneiss, mica schist, with their varieties, although in places, particularly on the west coast, slates of seemingly later origin may be seen flanking the older strata.

Generally speaking, it may be said that Caledonia is of very ancient formation; even the sandstones are decidedly metamorphic.

The Carboniferous system is represented by strata (sandstone) showing coal in the neighborhood of "Noumea" and "Urail," but clearly confined to a narrow coast strip at places, as at "Mont d'Or," it can be traced from the sea until, at a short distance, merely superimposed on the Plutonic rock.

The government is essentially autocratic, considering its nature and the great power placed in the hands of a few individuals. The fact that we are governed so well as we are, speaks much in favor of the French national character.

Governors are appointed for a term of years; hitherto, with one or two exceptions—notably Governor Guillan—they have ranged from bad to indifferent.

The present gentleman, Monsieur Pallu de la Barriere, a naval officer of distinguished merit, has so far realized the hopes raised by his appointment, where his predecessors were content to serve the time necessary to attain their promotions in their respective services, in the manner most suitable to their own ease and interests. The present Governor has brought to bear on the Augean work he has undertaken a grand fund of energy and earnestness of purpose, while his honesty and good intentions are above suspicion.

Although the French have been in possession of the island since 1843, the native tracks still remain, with the exception of a few score miles of road leading from the capital, the only means of communication by land; but this state of things will in two months more be considerably modified, as by that time a bridle track will be completed round the island, and his Excellency has declared his intention of making the tour on horseback.

Doubtless a marine road will shortly also be made to enable coasters to sail between the reef and mainland on the west coast. A little dynamite and intelligence would, I think, soon work wonders in this respect. The blasting of a few rocks in some places would open up miles of clear channel.

RARE FISHES.

A LARGE number of rare and curious specimens of deep sea fishes have just been received by Prof. Gill, of the Smithsonian Institution. They were caught by the crew of the Fish Commission steamer Albatross, the latter having just returned from an exploring expedition in mid-ocean. The Albatross was absent two months, during which time fish were captured representing thirty new species, twenty new genera, and three families. The British exploring steamer Challenger during a three years' cruise only secured specimens representing fourteen new genera. The wonderful success of the Albatross is therefore emphasized by scientific men in this city. The fish are caught by means of a dredge or net, which is sunk very often to a depth of 3,000 fathoms.

Among the strange denizens of the deep caught during the cruise are following: The *Anchenichthy*, or fish with a neck. This specimen resembles an eel, has a well formed neck, and was caught at a great depth. The *Gastrostonius Bairdii* (named after Prof. Baird). This odd looking fish was described in the *Popular Science Monthly* as "the wonder of the deep sea." It is a variety of the devil fish. The jaw bones are seven times as long as the cranium, and are attached to wings resembling fine black silk, which come together, forming a broad pouch. The fish swims about with its pouch open, acting in the capacity of a seine. Small fish are caught in the latter, and transferred to the mouth by means of suction. The "Baird fish" resembles a leather wing bat in some particulars, and has a long and scaly tail. The *Cryptopsaras*, or "angler with concealed rod," is a most remarkable specimen. It has a very large mouth, and extending from a concealed rod on the back is a baited line, which floats above the body. Small fish nibble at the line, and are captured by the "angler." The bait is a ball of jelly-like matter, which is so sensitive that instant notice is given when a fish touches it. Another member of the "angler" family is perfectly blind. It is known as the *Typlopsaras*, or "blind angler." This remarkable fish fisher was never heard of until the recent cruise of the Albatross, and it is said to inhabit the sea 2,000 fathoms below the surface. The *Hypercharistus Tanneri*, or fish with upper pectoral rays or finger separate, is a queer shaped and vicious little fish. It inhabits deep water and is named after Capt. Tanner, of the Albatross, whose hand the little creature tried to bite when landed on the deck of the steamer with the deep sea seine. It is jet black, and has teeth like a circular saw. The *Neurichthyids*, or snipe eel, is a genuine curiosity. Its body resembles that of an ordinary eel, while the head is a facsimile of that of the common marsh snipe which abounds in Maryland and Virginia. The tape fish is another interesting fish. It is of the size and thickness of ordinary tape, and when in the water is perfectly transparent and can only be seen by its little red eyes.

There are several other remarkable specimens. They are kept in jars of alcohol in Prof. Gill's office, and will appear in the illustrated annual reports as fish discovered thousands of fathoms below the surface of the Atlantic by the United States Fish Commission. They will also probably be placed upon exhibition in the National Museum or Smithsonian.—*National Republican.*

TROUT AND TROUT CULTURE.*

By R. A. Koss.

THE brook trout belongs to a family of fish the members of which are distinguished for their delicate flavor, and among which the salmon, the king among all food-fish, occupies the most prominent place. The trout is one of our most valuable fresh water fish, and recommends itself to the pisciculturist by many excellent qualities. The clearer, colder, and more rapid in their flow the waters are in which the trout lives the darker is its peculiar, many colored skin. It seems as if nature took special care not to make its appearance too striking, so as to attract the attention of its enemies, of whom man, after all, is not the worst. The trout, which in brooks reaches a weight of about three pounds, seldom more, is a very hardy fish, and not very choice in its food. It is not timid, and can even be easily tamed, in which case, on account of its voracity, it can be accustomed to take its food from a man's hand. It is particularly well adapted to pisciculture, because its eggs are very hardy and can easily be transported a considerable distance. Its power of digestion is very extraordinary, and when well fed it grows quicker than most other fish. Its food is exclusively animal, consisting principally of insects, larvæ, snails, and other small animals. All these water animals need aquatic plants for their existence, and these plants are, therefore, necessary indirectly to the trout. It occasionally eats fish but never shows as much liking for them as for the other articles of food mentioned above. When a number of trout living together have sufficient food, there will be among them but very few which eat fish, perhaps only one in a hundred, provided that the difference of size is not too great. The trout which eat fish grow quicker than their comrades; in retired places they lead the life of hermits, and their flesh is less delicate than that of other trout. If one succeeds in catching these destructive individuals no more fish will be eaten, for in the shallow brooks there will rarely be any other fish of prey. Trout do not like the company of other fish; it is well, therefore, to keep them separate from other fish as much as possible.

For spawning places the trout prefers shallow spots with a gravelly bottom, over which the water flows slowly and with broken force; the fecundity of the trout in a certain body of water depends altogether upon the extent of suitable spawning places. Whenever a brook has large stretches of gravelly bottom over which the water flows gently, it may be assumed with a great deal of probability that it contains trout. For supplying trout with food it is well if there are occasionally places where the bottom is muddy or peaty; a slow current is also much to be preferred to a rapid current flowing over a rocky bottom, because the former favors the development of water plants and small aquatic animals. Trout are very numerous in clear mountain streams, flowing rapidly over their rocky beds, because they like the character of the water; but they remain small, and do not get very fat; while slowly flowing rivers, having muddy bottoms, but fed by many gravelly brooks, where the fish can retire for spawning, produce the largest, fleshiest, and best flavored trout, which fetch the highest price in the market. It is a very general, but nevertheless erroneous, notion that trout only live in water which is clear and transparent as crystal; on the contrary, they seem not in the least disturbed by the water being muddy, and, as we have seen, a muddy bottom even favors their growth. In Norway, which is famous for its delicate trout, they flourish most in rivers and brooks with muddy bottoms, provided suitable spawning brooks are within easy reach. If there are in a body of water many stagnant places where aquatic plants grow in profusion, and hollow banks with entangled roots of trees and similar hiding places, the trout will flourish, even if the water does not flow very freely. Thus the river Leith, in Scotland, for example, is so shallow in many places during the summer that one can almost walk from bank to bank without wetting his feet; but it possesses a series of stagnant puddles extending for miles, which harbor an abundance of very large and delicately flavored trout.

It is likewise an erroneous idea that trout require very cold mountain water; they are, on the contrary, very well able to stand warm water, such as is found in the plains during the hot season. It has been observed in Germany that trout streams reached a temperature of 21, and even 26, degrees Reaumur, without in the least injuring the fish. A warm temperature of the water is even beneficial to trout, as it increases their food very considerably, which is an important item, considering their voracity. It is well, however, for trout streams flowing through a plain to have here and there along their banks bushes and shade trees, for during the heat of the day trout love to stay in such shady places, as under the overhanging branches and among the roots they find an ample supply of food, principally insects, which generally live on the leaves and are thrown into the water by the wind.

Trout culture is made comparatively easy by the circumstance that no other fish stays as steadily in one place without ever going far from it as the trout. Any person who lives near a stream, and is in the least observant, will be able to indicate the exact place of sojourn of this or that particularly striking individual trout. Apart from the spawning season the trout live permanently in a body of water extending frequently not more than 50 to 100 feet, which enables the proprietors of small bodies of water to use them advantageously for trout culture. When trout are well taken care of, they prefer to stay within narrowly confined limits; they learn to know man, approach him without fear, and even jump out of the water to get some food which is held out to them, in which case, however, one has to be careful not to get hurt by their sharp teeth.

If trout are well fed they begin to spawn when two years old, and it has even happened that trout only one year old have been known to discharge mature spawn. Two year old trout lay from two hundred to five hundred eggs, three year old ones about a thousand, and those from four to five years old even as many as two thousand. To stock a moderately sized stream with trout requires at least ten thousand young fish per annum. If this has been continued for three years one may, with tolerable certainty, count on good trout fishing. As a general rule trout flourish better in brooks, where they take care of themselves, than in ponds, where they have to be fed artificially. They need human protection only until they are able to seek their own food. Where there is no running water they can be kept in that which is still, provided that the latter is constantly kept pure by inflowing springs.

If there are no suitable natural spawning places, a spawning and hatching establishment may take their place; and it is well known that during the last decades a great deal has been done in the way of artificial trout culture. It requires a good deal of technical knowledge to start and superintend such establishments, but the expenses are very trifling compared with the great profit. Natural trout-culture is much less profitable, because it has been calculated that, left to themselves, one thousand eggs will produce, on an average, only one fish, while in a well conducted piscicultural establishment eight to nine hundred fish may be raised from the same number of eggs. The very waters in which trout flourish most have frequently no suitable spawning places, and if the supply is limited to the result of natural propagation the trout must soon die out, or, at any rate, become very scarce. Young fry from a piscicultural establishment are best placed at first in small streams or brooks with a gravelly bottom and retained there for some time by means of a wire grating.

As trout find much more food in the brooks and streams above referred to (sluggish, well-shaded waters) than in gravelly mountain streams, and consequently grow faster and acquire a more delicate flavor, a wide and exceedingly profitable field is here opened to the pisciculturist. The prejudice that trout are difficult to raise and that they are very choice in the selection of water cannot be sufficiently combated. As soon as they are able to forage for themselves they will be satisfied with almost any kind of water, provided it contains sufficient food. A brook containing pike and perch, but no spawning places for trout, will have to be stocked with ten times as many young fry, if any good fishing is looked for, as are required for an open mountain stream which is free from those two fish; but by means of artificial pisciculture the necessary quantity of young fry can easily be procured.

Mr. Peard, an Englishman, has made very practical suggestions for improving small trout-brooks. As we have seen, trout flourish best in streams which have not only a gentle current of water flowing over even places, but also a considerable number of large, deep, and calm pools. These are the favorite hiding places and winter quarters of the fish, as the aquatic plants grow in profusion in quiet water, supplying ample nourishment for insect life, and quantities of food are usually brought together in such places by the cur-

* "Forellen und Forellenzucht." Translated from the German by Hermann Jacobson.

rents. Whenever there are no such pools they can easily be made artificially, for which purpose cross dikes are constructed in the bed of the stream, at a distance of one hundred to one hundred and fifty feet, and strengthened by sod, sand, and stones. Below these dikes holes are dug, three to five feet deep and six to seven feet long, in each of which are placed some large and several small stones, or flagstones. The fish are thus provided with suitable hiding places, and fish thieves are foiled in their endeavors to catch trout with nets. As these dikes produce small waterfalls, the pools are increased by every high water, if proper care is only taken that the floods do not carry the dikes away. They should extend several feet on the bank, so as to prevent the water from flowing past them; and then the soil carried along by the stream will continually make the dikes stronger and stronger.

In our age, when it is often so exceedingly difficult for a man to make a living, it is absolutely necessary for the farmer and landed proprietor to husband his resources, and to derive the greatest possible benefit from his property. A stream or a pond, unless used for purposes of irrigation, was formerly considered almost like dead capital, and attempts were even made to lay it dry, with the view of using the land thus gained to greater advantage. In our days no landed proprietor should be found guilty of such folly. By utilizing such waters for pisciculture, the first expenses of which are, as a general rule, very slight, a tenfold greater profit can be realized than by laying them dry and using them for agricultural purposes. In nearly every part of our country there are thousands of such ponds and streams which at present are entirely useless, but which if stocked with fine food fish would become a rich source of income to their owners. Of all the various branches of pisciculture, trout culture is certainly the easiest and most profitable, and all persons who are in any way in a condition to carry on this business should give all possible attention to it.—*Bulletin U. S. Fish Commission.*

EXPERIMENTS ON THE COLORS OF GEMS.

LT.-COL. W. A. ROSS, 1871, tried to obtain a blue color by dissolving pure alumina in a pearl of borax. After a half-day's work he obtained a very pale blue pearl, hard enough to scratch glass. This experiment led him to think that the blue color of sapphire is due to its 98 per cent. of alumina, and not to the traces of any metallic oxide. In the following year experiments with lime which had been freshly calcined and with hydrate lime, showed a remarkable influence of the water upon the coloring, both of the flame and of the pearl. In 1873 he found that by dissolving pure alumina, under the blow-pipe, in a pearl of boric acid which had been opalized by means of platinum, and adding a small proportion of hydrate of potassium, he obtained a bluish pearl, much more rapidly and easily than by his first experiment. Some years later he bought, in London, a little American wavellite. On treating the powder of this mineral under the blow-pipe, in an opalized or hydrated pearl of borax, with a little hydrate of potash, he was astonished to see that his pearl became purple, then blue, and finally of a brilliant green. Subsequent experiments satisfied him that although phosphoric acid had not been discovered in sapphire or in lapis lazuli, it may have contributed to their coloring; for lazulite, which is similarly blue, is essentially a phosphate of aluminum, and pure phosphoric acid is well known to be one of the most deliquescent substances in nature. The colors which can be produced by the aid of these three colorless substances, hydrated phosphate of aluminum, hydrated boric acid, and hydrate of potassium, are purple, or amethyst, green, blue. Heintz has proved that the color of amethyst is not due to manganese or to titanic acid. Some chemists erroneously attribute the green color of the emerald to a trace of chromic acid; but chrome dissolved in the blow-pipe pearls invariably gives a pinkish hue.—*Ann. de Chem. et de Phys.*

ON THE CONDENSATION OF GASES.

A PAPER detailing results has appeared in the *Anzeiger der Wiener Akademie der Wissenschaften* and the *Comptes Rendus*, xcvi., 1140. It treats of the facts arrived at by S. Von Wroblewski and K. Olszewski.

They say that the results which Cailletet and R. Pictet obtained in their valuable work "On the Liquefaction of the Gases," lead us to hope that the time is not far distant when we shall be able to as easily examine liquid oxygen in a glass tube as it is at present to look at a tube filled with carbonic acid in the liquid state. The one condition which must of necessity be arrived at is a sufficiently low temperature. In a paper published by Cailletet a year ago he directs attention to fluid ethylene as a means of reaching an exceedingly low temperature. This gas, in a fluid state, boils under the atmospheric pressure at —105°, as measured by a thermometer of carbon disulphide. Cailletet himself compressed oxygen in a very narrow tube, and cooled it down to —105° in this fluid. In the moment of expansion he saw a tumultuous ebullition; it boiled during an appreciable time, and resembled the projection of a liquid in the cooled part of the tube. This ebullition was formed at a certain distance from the bottom of the tube. "I was not able to recognize," he goes on, "whether the liquid pre-existed or whether it formed at the moment, because I was not able to see the separation of the liquid and the gas." S. Von Wroblewski has recently constructed a new apparatus for higher pressures, in which considerably large quantities of gas can be subjected to a pressure of 200 atmospheres, and with this apparatus it is proposed to study the temperatures at the moment of expansion. The experiments soon led them to the discovery of a temperature at which carbon disulphide and alcohol became solid, and oxygen is rendered completely liquid with the greatest ease. This temperature is reached by letting liquid ethylene boil in a vacuum. The boiling point depends, of course, in such a case, on the goodness of the vacuum of the pump. By the vacuum which, up to the present, it has been found possible for us to attain, the temperature falls to —136°. This low point—in fact, all the temperatures which we place on record—are measured with the hydrogen thermometer. The critical temperature of oxygen is lower than that at which the liquefied ethylene boils under the pressure of one atmosphere. The latter is not —105°, as at first it was assumed to be, but lies between —102° and —103°, as is shown by our thermometric observation. From a number of determinations which we have made we quote the following, which will serve to show where the point lies:

Temperature.	Pressures in atmospheres under which the oxygen begins to liquefy.
—131·6°	26·5
—133·4	24·8
—135·8	22·5

Liquid oxygen is colorless and as transparent as fluid carbonic acid, it is very mobile and exhibits a very beautiful meniscus. Carbon disulphide freezes at about —116°, and again becomes liquid at about —110°. Absolute alcohol at about —129° is thick and viscous like oil, and at about —130·5° solidifies to a firm mass. The more accurate numbers will be given in another paper. In the same way as referred to above, the author endeavored to liquefy nitrogen and carbonic oxide. The liquefaction of these two gases is brought about with more considerable difficulty than in the case of oxygen, and under such similar conditions that at the moment it is difficult to say which of the two gases is the easier. At a temperature of about —136°, and under the pressure of about 150 atmospheres, neither nitrogen nor carbonic oxide appears to liquefy. The glass tube with the gases appears to be quite transparent, and no traces of liquid can be observed. If the gas is suddenly freed from the pressure, there is remarked in the tube containing the nitrogen a powerful boiling up of the liquid, which is best compared with the boiling of liquefied carbonic acid in a Natterer's tube when it is placed in hot water. In the case of carbonic oxide the boiling does not take place in so strong a degree. If, however, the expansion be not allowed to take place so suddenly, and it be allowed to sink to 50 atmospheres, both the liquefied gases, nitrogen and carbonic oxide, evaporate completely, the liquids show a perfect meniscus, and rapidly evaporate. The two gases can only be retained for a few seconds in the form of liquid in the static condition. To retain them longer in that state a somewhat lower temperature must be reached than we have at present succeeded in attaining. Nitrogen and carbonic oxide in the condition of liquids are, both of them, colorless and transparent.

LEAD.

LEAD is a bluish white metal of considerable brilliancy, which soon disappears on exposure to the air, owing to the formation of a thin film of oxide. It is so soft that it may be readily cut with a knife, or may be made to take impressions, and it leaves a streak upon paper. It may be cut or beaten into thin sheets, but in ductility and tenacity it is low in the scale of metals. It is readily fusible at a temperature of about 625°, and at a higher temperature it absorbs oxygen rapidly from the air, and the oxide thus formed volatilizes in the form of white fumes.

The combined action of air and water on lead is a subject of great practical importance, in consequence of the metal being so frequently employed in the construction of cisterns and water pipes. The lead becomes oxidized at the surface, and the water dissolves the oxide; this solution absorbs the carbonic acid of the atmosphere, a film of hydrated oxicarbonate of lead is deposited in silky scales and a fresh portion of oxide of lead is formed and dissolved, and in this way a rapid corrosion of the metal ensues. This action is materially increased by the presence of some salts, and diminished by the presence of other salts in the water. It is much increased by the occurrence of chlorides (which, as chloride of sodium, is often present in spring water), and of nitrates and nitrites (which are often present in spring and river waters, from the decomposition of organic matter); while it is diminished by the sulphates, phosphates, and carbonates, and especially by carbonate of lime, which is an extremely common impurity in spring water. In the latter case, a film of insoluble carbonate of lead is rapidly formed on the surface, and the metal beneath is thus protected from the action of the water. If, however, the water contains much carbonic acid, the carbonate of lead may be dissolved; and considering the dangers that arise from the use of water impregnated with lead, cisterns constructed of slate are far preferable to leaden ones.

Pure lead is of very rare occurrence. Almost all the lead of commerce is obtained from galena, the native sulphide of lead, by a process to be explained afterward. The lead thus obtained is often nearly pure, and to obtain it perfectly pure it should be reduced with black flux from the oxide left by igniting the pure nitrate or carbonate.

The compounds of lead with oxygen are four in number—viz., a sub-oxide which is a black powder of no importance; a protoxide, which is the base of the ordinary salts of the metal; a binoxide; and red lead, which is a compound of the two last named oxides. The protoxide is commonly known as litharge. It is obtained on a large scale by the oxidation of lead in a current of air, when it forms a scaly mass of a yellow or reddish tint. If the oxidation be effected at a temperature below that required for the fusion of oxide, a yellow powder, termed massicot, is obtained. Litharge is much used by the assayer as a flux; it enters largely into the composition of the glaze of common earthenware and into the manufacture of glass; and it is employed in pharmacy in the preparation of plasters. A mixture of one part of massicot with ten of brick dust, made into a paste with linseed oil, forms the compound known as dhil mastic, which, from the hardness with which it sets, is frequently employed to repair defects in stone facings.

The most important of the salts of the protoxide of lead are: 1. The carbonate, which occurs native as a beautiful mineral in transparent needles or fibrous masses, and which is prepared under the name of white lead on a large scale as a pigment by a process which we shall subsequently describe. The carbonate is insoluble in water, unless it is largely charged with carbonic acid. It is generally blackened by exposure to hydrosulphuric acid (sulphureted hydrogen), either in the form of gas or in solution, and this is a serious drawback to the use of lead salts as pigments. 2. The sulphate, which occurs native in white prismatic crystals, and is formed as a heavy white precipitate on adding sulphuric acid or a soluble sulphate to a soluble lead salt. 3. The nitrate, which is formed by dissolving lead or its protoxide in dilute nitric acid. 4. The chromates, of which the principal are the neutral chromate, or chrome yellow, and the di chromate, or orange chrome. They are much used as pigments, and in calico-dyeing. 5. The acetates. The ordinary or neutral acetate is prepared on a large scale by the solution of litharge in distilled vinegar, and evaporation, when the salt is obtained in four sided prisms, or more commonly in a mass of confused minute white crystals, which at 212° lose their water of crystallization. From its appearance and from its sweetish taste, it derives its common name of sugar of lead. It is used both in medicine and the arts. Basic acetate of lead, regarded by some chemists as a diacetate, and by others as a triacetate, and commonly known as Goulard's extract, is prepared by boiling a solution of sugar of lead with litharge, and adding alcohol, when the salts separate in minute transparent needles.

The best test for solutions of the salts of lead are the formation of a black sulphide with hydrosulphuric acid or hydrosulphate of ammonia, insoluble in an excess of the reagent; of a white insoluble sulphate with sulphuric acid, or a soluble sulphate; of a yellow chromate with chromate of potash; and a yellow iodide with iodide of potassium. All the salts of lead, insoluble in water, are soluble in a solution of potash. Before the blow-pipe on charcoal, the salts of lead yield a soft white bead of the metal, surrounded by a yellow ring of the oxide.

Lead is an important metal in the arts. Rolled out into sheets, it is largely used for roofing houses, for water cisterns, and for water pipes. It is also of great service in the construction of large chambers for the manufacture of sulphuric acid. Its value in the manufacture of shot is well known. Alloyed with antimony, etc., it is largely consumed for type metal, and with tin for solder. Much lead is also required for the manufacture of pewter, Britannia metal, etc.

The most important compound of lead in the materia medica is the acetate of lead, which is administered internally as an astringent and as a sedative. It is of service as an astringent, especially in combination with opium, in cases of mild domestic cholera, and even of Asiatic cholera, and in various forms of diarrhœa. It will frequently check the purulent expectoration in phthisis, and the profuse secretion in bronchitis. In the various forms of hemorrhage—as from the lungs, stomach, bowels, or womb—it is employed partly with the view of dimishing the diameter of the bleeding vessels, and partly with the object of lowering the heart's action, and by these means to stop bleeding. The ordinary dose is two or three grains, with half a grain of opium, in the form of a pill, repeated twice or thrice daily. If given for too long a time, symptoms of lead poisoning will arise.—*Glassware Reporter.*

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TABLE OF CONTENTS.